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AIR FORCE

HUMAN RESOURCES LABORATORY

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NAVIGATOR-OBSERVER UTILIZATION FIELD
FLYING SPECIALTIES STUDY
APPENDIX II. COMMON AND NON-COMMON
OPERATIONAL TASK REQUIREMENTS

By
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Raymond J. Heapy
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Manned Systems Sciences, Inc.

FLYING TRAINING DIVISION
Williams Air Force Base, Arizona

April 1972

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FOREWORD

This appendix documents the results of work performed during Phase II of Contract No. F41609-71-C-0014 by MANNED SYSTEMS SCIENCES, INC., 8949 Reseda Blvd, Suite 206, Northridge, California.

The objective of Phase I (Appendix I) was to examine the present and future roles of the Air Force navigator. Phase II addressed describing, analyzing and determining commonality among requisite operational navigator tasks. Phase III (Appendix III) analyzes present and future navigator training requirements. Research requirements are documented in a separate unpublished Phase III report.

The study was initiated under Project 1123, Flying Training Development, Task 1123-06, Task Analysis and Inventory for Flying Training Program Development. Dr William V. Hagin was project scientist and Major Robert E. MacArgel was task scientist. This report covers the period between 1 May 1971 and 30 September 1971.

The authors wish to express their appreciation to the numerous Navigator-Observers who participated in interviews, simulator exercises and inflight observations associated with task data collection and validation activities.

This report was submitted by the authors in September 1971.

This technical report has been reviewed and is approved.

GEORGE K. PATTERSON, Colonel, USAF
Commander

ABSTRACT

Appendix II presents information developed during Phase II of a three-phase study designed to provide a technical basis for determining future (1975-1990) navigator training requirements. The term navigator is used generically to refer to Navigator (AFSC 1535), Radar Navigator (Navigator-Bombardier) (AFSC 1525), Weapon Systems Officer (AFSC 1555), and Electronic Warfare Officer (AFSC 1575). This appendix addresses the methodology which was developed and used to determine common and non-common operational task requirements across all navigator flying specialties, as well as within each flying specialty. Task description and analysis methods are presented along with data collection and validation procedures. Computer software developed for determining common and non-common tasks is presented. Rationale for deriving task commonality criteria is addressed. Supplementary Phase II classified task analysis and commonality analysis information is presented in a separate section (Section IX) of the secret Appendix I, entitled, "Present and Future Roles of the Navigator" (U) in order to keep all classified information in a single document for control purposes.

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SECTION I

INTRODUCTION

Instructional System Development (ISD) (Ref. 1) is a deliberate and orderly process of planning and developing instructional programs to ensure that personnel are taught the knowledges and skills essential to successful job performance. Such planning requires decision making, and decision making requires information. The Navigator-Observer Utilization Field Flying Specialties Study (NOUFFSS) is designed to provide a solid foundation of information to assist in the development of navigator training philosophy, training program design, and identification of research. Both the near term (1971-1974) and the future (1975-1990) are addressed.

The Navigator-Observer Utilization Field (AFSC 15XX) has evolved into a complex set of job types including four flying specialties:

AFSC 1525	Radar Navigator
AFSC 1535	Navigator
AFSC 1555	Weapon System Officer
AFSC 1575	Electronic Warfare Officer

For simplicity, the term "navigator" is used in the generic sense in the remainder of this report to refer to the entire 15XX career field, unless otherwise specified.

The four flying specialties may appear to have cohesiveness and continuity because they are in the same flying field. Indeed, there is some degree of job similarity between the Navigator AFS and the Radar Navigator AFS. To some extent, the job similarity continues through the Weapon System Officer AFS. However, there presently is little continuity between job requirements of these specialties and the job of the Electronic Warfare Officer. These factors have complicated the navigator training process.

Rapid advances in technology also have complicated the navigator training process. Further advances promise to markedly alter the roles and tasks of at least some weapon system navigators. Accordingly, the navigator training system must prepare to teach the skills and knowledges required by changing missions, technologies and navigator roles.

Several very significant changes may be anticipated for navigator training in the very near future. Many of the changes will be related to the introduction of new and more sophisticated training devices. These will include: the T-43 Navigator Training Aircraft and the T-45 Undergraduate Navigator Training Simulator (UNTS), and the Simulator for Electronic Warfare Training (SEWT). Broad spectrum changes, however, will probably have their fullest collective impact in the post 1975 timeframe.

Between now and then, many training philosophy, policy, content and method questions must be answered. Representative questions are:

- In which operational, mission-imposed tasks must the navigator be proficient?

- Which operational tasks are common to the broad spectrum of navigators?

- Which operational tasks are highly unique to particular navigator AFSCs?

- What is the navigator AFSC structure apt to be in the future?

- Should total navigator training system organization be restructured to accomplish the necessary training?

- Should major modifications be made to course content or student performance standards?

- Would minor modifications to course content training methods and media be sufficient?

- Which methods and media would most effectively enhance the student's acquisition of necessary skills, knowledges and proficiencies?

- What objective, measurable performance standards should apply to the many different learning tasks?

- What are criterion objectives, and how should they be sequenced and interrelated in a modified training program?

- What are enabling objectives, how are they developed, and how should they be interrelated and sequenced in a modified training program?

- Are training program changes even required?

Historically, such questions could not be answered with assurance, primarily because information needed to make the necessary decisions was largely not available. These and other factors made it necessary to accomplish a systematic analysis of navigator training requirements. It has been the objective of the NOUFFSS study to perform the analysis and thereby provide much of the needed information.

The necessary analysis requires a highly structured and comprehensive procedure for determining training requirements. The NOUFFSS study is addressing this requirement through three distinct, but highly interrelated phases.

Phase I examined the present role of the Air Force navigator and projected his role into the future. The factors addressed during Phase I have been documented as Appendix I to AFHRL-TR-72-10.

Phase II, which is the subject of this appendix, provided an objective means of determining common and non-common navigator operational tasks. Phase II, therefore, consisted primarily of a task analysis activity. The task anlaysis was predicated upon the following principles: What should be taught should be based largely upon operational task requirements. How to train should be based, to a large extent, upon what must be taught. Task analysis data are useful for curriculum and syllabus development.

Phase II was accomplished by first identifying, describing and analyzing requisite navigator operational tasks for a selected, representative sample of weapon systems and missions. Techniques and criteria were then developed to computer sort the task data in order to identify tasks which are common to many navigator AFSs, missions and weapon systems, as well as those which are quite unique. Determination of common and non-common tasks was accomplished for four distinct time periods between 1971 and 1990. The underlying assumption was that resulting information may be generalized beyond the Phase II sample.

The Phase III objective was to develop information which will assist navigator training personnel in developing new training programs and furthering training program continuity. Accomplishment of this objective required the use of information from both Phases I and II. During Phase III, common and non-common operational tasks were compared with present navigator training requirements. The changing role of the navigator, as developed during Phase I, was used in projecting future training requirements. Based upon the comparisons, present training requirements were evaluated. New training requirements were developed where required. All training requirements were then stated in terms of criterion objectives. The Phase III effort is documented as Appendix III to AFHRL-TR-72-10. Research requirements also were developed during Phase III and are documented in a separate unpublished report.

Remaining sections of this appendix emphasize the methodology which was refined and used to accomplish the Phase II objectives. The implications, applications and computations which comprise the methodology are not overly complex, but do require a thorough understanding of several independent yet interlocked concepts and procedures. The NOUFFSS commonality analysis represents only the second program application of a commonality analysis methodology. Hence, the methodology is addressed in considerable detail in this report. This is done to provide the

reader with the fundamental information required to fully understand the component areas contributing to the final analysis and to establish the framework of logic which assembles and interrelates the component areas. Particular attention has been given to the fundamental structure of the task analysis, the use of different aircraft/AFSC task data sorts, the development and use of commonality weighting factors, interpretation of the commonality analysis computer output, and the overall procedures and rationale used to address development of quantitative task commonality criteria. The concepts and problems associated with task commonality and commonality analysis findings will be meaningful only when the components and logic of this relatively new methodology are fully understood.

SECTION II

TASK ANALYSIS REQUIREMENTS

INTRODUCTION

Phase II of the NOUFFSS study was tasked with describing and analyzing the requisite operational tasks performed by Air Force weapon system navigators. Phase II also was tasked with determining the degree of commonality of the tasks within each navigator-observer flying specialty across weapon systems, and among all flying specialties across weapon systems. These requirements necessitated two fundamental system procedures: task analysis and commonality analysis. This section addresses task analysis requirements.

DEFINITIONS

What is a task analysis? Miller (Ref. 3) has defined a general systems task analysis as the enumeration of discriminations, decisions and action-responses which are necessary and sufficient to operate a mechanism within the tolerances required by the man-machine combination. In general, then, task analysis is a procedure which results in the organized presentation of the job elements which are carried out by the human operator during the use or maintenance of a man-machine system.

Generally, task analysis is performed during the design of complex systems to provide information for decision making during successive stages of system design. Task analysis information bears upon ramifications of human behavior in the operation or maintenance of the final system (Ref. 4). Task analysis, therefore, is a method for providing information regarding human components within a systems context.

Uses of task analysis data include: identification of job-elements which singly or in combination are incompatible with human abilities; specification of personnel requirements for manpower selection and planning; and development of training programs. In NOUFFSS Phase II, task analysis data were developed for use in training program design.

Regardless of the application, task analysis consists of two fundamental steps: description of job behaviors, and analysis of the behaviors for design content. Both the descriptive and analytic aspects of the task analysis are discussed in this section. Prior to presenting task descriptive and analytic elements, however, requisite methodological constraints and data collection methodology are presented to provide background for the conceptual and developmental characteristics of the NOUFFSS task analysis.

REQUISITE METHODOLOGICAL CONSTRAINTS

Introduction. The following constraints are needed to develop a task analysis technically suitable for a detailed commonality analysis. The constraints actually represent solutions to numerous problems which relate to careful task analysis preparation.

Subjective Procedure. At best, both the descriptive and analytic steps of a task analysis are subjective. Subjectivity means that several different task analysts are quite apt to describe the "same" task in somewhat different terms. Such occurrences are catastrophic to the successful determination of common and non-common tasks across a diverse spectrum of weapon systems, missions, and crew positions. Accordingly, a primary requirement in NOUFFSS Phase II was to develop a workable task analysis methodology. The methodology had to control, channel and standardize task analysis data developed by individual analysts, while not stifling the subjective and creative task analysis process.

The problem is placed in a more defined context by Tables 1, 2 and 3. Table 1 presents the total NOUFFSS weapon system sample. Table 2 shows the mission phases flown by the weapon system sample. Table 2 also shows the first step in solving the commonality problem through the development of a fixed set of mission phases broad enough to cover the operational requirements of the entire weapon system sample. Table 3 shows the navigator crew positions for the weapon system sample.

A basic requirement was to develop a methodology wherein operational task requirements could be consistently identified for 14 different crew positions in 11 different weapon systems flying a total of 14 different types of mission segments. Furthermore, the bulk of data to be handled in determining common and non-common tasks required the use of a computer. Computers cannot effectively "read between the lines" without extensive software utilization. Because extensive software was beyond the scope of Phase II, the methodology had to ensure that data input to the computer were totally unambiguous.

The solution to these problems was accomplished by highly structuring all task descriptions. In this manner, task analysts were required only to make yes-no decisions rather than more highly subjective task content decisions.

Table 1. Total NOUFFSS Weapon System Sample.

Weapon Systems		
C-130E	FB-111A	F-4E
C-141A	B-1A	RF-4C
C-5A	KC-135A	AWACS
B-52G	F-111A	

Function/Task Description and Standardization. During Phase I (Ref. 2), mission descriptions and navigator functions were developed for all weapon systems in the NOUFFSS sample. The first step was to review the mission descriptions and develop the mission phase set shown in Table 2. Function-level data were then reviewed in order to begin solution of a primary problem in all task analyses - achievement of consistent levels of detail in function/task description. Functions were defined as broad system activities contributing to mission performance. Tasks were defined as units of work performed by the navigator in order to accomplish a functional-level requirement. Subtasks were defined as sub-goals associated with or required for the accomplishment of task-level behavioral requirements. The three levels of job description present progressively more detailed descriptions of navigator operational performance. A further discussion of the levels is presented in this section under Task Analysis Elements.

Development of a fixed set of functions was an iterative procedure which was pursued in conjunction with the development of fixed sets of tasks within each function. Similarly, fixed sets of subtasks were developed for each task. During the development of the three levels of operational job description, considerable attention was devoted to adjusting the information to achieve relative consistency (standardization) of descriptive detail within each level.

Functional vs. Timeline Orientation. The function, task, and subtask data developed for the standardized catalog all reflect a "functional orientation" to job description. It is important to differentiate between a timeline or time sequence orientation and a functional orientation.

A timeline orientation is based totally upon the sequences and time intervals during which events occur. This type of analysis is useful when dealing with equipment design or training requirements for a particular piece of equipment. Quite frequently, the sequence and time for performance of proceduralized steps is highly critical to task accomplishment or equipment safety. However, the NOUFFSS Phase II methodology had to be designed to be workable across a broad spectrum of

Table 2. Mission Phases Flown by Weapon Systems in NOUFFSS Sample.

NOUFFSS MISSION PHASES	WEAPON SYSTEMS									
Preparation	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Preflight	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Takeoff	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Cruise	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Refuel				B52	FB111	B1	KC135	F111	F4	RF4	
Cargo Drop*	C130	C141	C5								
Penetration				B52	FB111	B1		F111	F4		
Weapon Delivery				B52	FB111	B1		F111	F4		
Sector Patrol											AWACS
Reconnaissance										RF4	
Air superiority									F4		
Land	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Post Flight	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS
Emergencies	C130	C141	C5	B52	FB111	B1	KC135	F111	F4	RF4	AWACS

*Air Drop

Table 3. Navigator Crew Positions in NOUFFSS Sample.

Weapon System	Crew Position	
C-130E	AFSC 1535	Navigator
C-141A	AFSC 1535	Navigator
C-5A	AFSC 1535	Navigator
B-52G	AFSC 1535	Navigator
	AFSC 1525	Radar Navigator
	AFSC 1575	Electronic Warfare Officer
FB-111A	AFSC 1525	Radar Navigator
B-1A	AFSC 1525	Radar Navigator
	AFSC 1575	Electronic Warfare Officer
KC-135A	AFSC 1535	Navigator
F-111A	AFSC 1555	Weapon System Officer
F-4E	AFSC 1555	Weapon System Officer
RF-4C	AFSC 1535	Navigator
AWACS	AFSC 1535	Navigator

equipments and navigator operational requirements. A timeline orientation would have been far from optimum to satisfy this requirement. The timeline approach, however, frequently is more useful in the development of performance measurement and performance standards.

The functional orientation which was adopted stressed the types and kinds of activities which navigators are required to perform. The approach allowed for the factoring of behavioral events into more meaningful clusters. For example, the functional orientation provided a context for addressing preflight equipment checkout primarily at the subsystem level, rather than in the context of long series of checklist items. The approach, therefore, provided a context for addressing each of the types of subsystem checkout, rather than providing a task context which would simply have said, "Perform checkout procedures." Examination of the catalog in Section V will clarify this critical difference. The functional orientation provided a context for more informative task and subtask description. It also provided the methodological basis necessary for the development of the comprehensive and standardized catalog which was pivotal to the success of Phase II.

The methodological approach described above is fundamentally an expansion and refinement of a basic methodology developed by Semple and Majesty (Ref. 5). The modified methodology used during Phase II was designed to eliminate the numerous problems encountered in first implementing the basic methodology. The modified method, although laborious and time consuming, was demonstrated to be viable, and ultimately provided a sufficient degree of control over multiple analysts and diverse operational contexts and systems to allow for the identification of job commonality down to the subtask level of descriptive detail.

Task Catalog Development. Three primary sources of information were used to develop the standardized task analysis catalog. Personal knowledge of analysis team members was the starting point. This knowledge was supplemented by information obtained from numerous documents such as aircraft Technical Orders, checklists, MAC, SAC and TAC manuals, existing task analyses, R&D study documents, and future weapon system specifications. Additionally, two visitations were made to operational units to discuss and validate the task analysis data with navigators in each operational weapon system in the NOUFFSS sample. Because relevant information was being obtained over fully four of the five months allotted for Phase II, development of the catalog was evolutionary rather than revolutionary.

Five rules were adopted during the development of the catalog. First, any function could appear under only one mission phase. Second, any task could appear under any one function. Third, any subtask could appear only under one task. Fourth, each function, each task, and each subtask was assigned a unique numeric code. The fourth rule provided the latitude

necessary to take into account legitimate cases where the same task might be required for the accomplishment of more than one function, or where the same subtask might be required for the accomplishment of more than one task. In these cases, unique numeric codes were assigned (rather than re-using the same numeric code). The fourth rule was used only a very limited number of times. It was required, however, in order to make the first three rules meaningful.

The fifth rule required that all changes to the evolving catalog be accomplished in meetings at which the majority of the analysis team were present. In this manner, newly gained information relating to several weapon systems and crew positions could be compared, and the analytic abilities of several individuals focused upon the decision making requirement. After any additions, deletions, or changes to the master catalog, all analysis team members' catalogs were immediately brought up-to-date. Periodically, all task descriptions and analyses which had been partially or totally completed were reviewed and updated.

Revision of the catalog continued into the last month of Phase II in order that it would validly and comprehensively reflect all operational task requirements. When the catalog was finally frozen, all functions, tasks, and subtasks were assigned new, unique numeric codes. All task analysis sheets were updated to incorporate the new codes. This was done to ensure that no function, task, or subtask shared a common number and to simplify computer software requirements.

The function, task, and subtask information developed for the task analysis catalog is contained in Section V of this report. Details of the data collection methodology are contained in the following section.

TASK ANALYSIS ELEMENTS

Introduction. NOUFFSS task analysis data elements may be divided into two fundamental data categories; descriptive elements and analytical elements. Descriptive elements were of several types as listed below, but all generally required the specification of system-specific (unique) data entries. Analytic elements consisted of both unique (such as skills and knowledges) and standardized (tables or scales of criticality, difficulty, etc.) data specification.

On the task analysis forms which were used, the data elements were arranged in a manner which facilitated data collection, data packing and keypunching. Examples of function/task and subtask data collection forms are presented in Figures 1 and 2 respectively. Figure 3 presents an example of the final task analysis computer printout.

01 FN ___ D __________ S __________

02 MN ______________________________ P ______________

03 FUNC ____

04 TASK ____

05 TN ______ ENT ______ TIME __._

06 SRCE ____

06 SRCE ____

07 TICN ____

08 TALT ____

[illegible]8 TALT ____

[illegible] ____

Figure 1. Task Analysis Data Collection Form for Function/Tasks.

09 SN ______ SC 15______ FR ____ CR __ DP __ DL __ TD __ MD __ T __.__

10 SYS ______________________ HDW ______________________ NO ______________________

10 SYS ______________________ HDW ______________________ NO ______________________

10 SYS ______________________ HDW ______________________ NO ______________________

10 SYS ______________________ HDW ______________________ NO ______________________

11 SKILL ____

11 SKILL ____

12 KNOWL ____

12 KNOWL ____

13 MP ______________ MS ______________ MP ______________ MS ______________

13 MP ______________ MS ______________ MP ______________ MS ______________

13 MP ______________ MS ______________ MP ______________ MS ______________

14 SUBT ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

15 MFTN ____

Figure 2. Task Analysis Data Collection Form for Subtasks.

```
01        FN 24      D 070971   S C-130E                                              091792
02        MN COMBAT AIR DROP          P EMERGENCY                                     091793
03   FUNC EXECUTE EMERGENCY PROCEDURES                                                091794
04   TASK PREPARE FOR DITCH OR CRASH LANDING                                          091795
05        TN 092     ENT 039    TIME 07.2                                             091796
06   SRCE INTERVIEW TO 1C-130B-1CL-2                                                  091797
07   TICN ORDER TO DITCH OR CRASH LAND                                                091798
08   TALT NONE                                                                        091799


09        SN 390     SC 1535    FR  1  CR 5  OP 1   DL 1   TO 4   MO 1   T 03.0       091800
10        SYS LIFE SUPPORT      HDW HELMET          NO N/A                            091801
10        SYS LIFE SUPPORT      HDW ANTIEX SUIT     NO N/A                            091802
10        SYS LIFE SUPPORT      HDW SEAT BELT       NO N/A                            091803
10        SYS LIFE SUPPORT      HDW LPU             NO N/A                            091804
11        SKILL NA                                                                    091805
12        KNOWL NA                                                                    091806
13        MP PROCEDURE          MS SEQUENCE  MP TIME             MS 3 MIN             091807
14   SUBT PREPARE EMERGENCY AND SURVIVAL EQUIPMENT                                    091808
15   MFTN DON ANTIEXPOSURE SUIT                                                       091809
15   MFTN DON LPU                                                                     091810
15   MFTN STOW EMERGENCY EQUIPMENT                                                    091811


09        SN 391     SC 1535    FR  1  CR 5  OP 1   DL 2   TO 4   MO 1   T 0[illegible].2       091812
10        SYS LIFE SUPPORT      HDW SEAT BELT       NO N/A                            091813
11        SKILL CREW COORDINATION                                                     091814
12        KNOWL DITCHING PROCEDURES                                                   091815
12        KNOWL CRASH LANDING PROCEDURES                                              091816
13        MP NA                 MS NA                                                 091817
14   SUBT ASSUME DITCHING OR CRASH LANDING POSITION                                   091818
15   MFTN ASSUME APPROPRIATE DITCH POSITION                                           091819
15   MFTN FASTEN SEAT BELTS AND SHOULDER HARNESS                                      091820
15   MFTN SECURE INERTIAL REEL                                                        091821


09        SN 392     SC 1535    FR  1  CR 6  OP 5   DL 1   TO 4   MO 1   T 02.0       091822
10        SYS LIFE SUPPORT      HDW SURVIVAL EQPT   NO AS REQD                        091823
11        SKILL NA                                                                    091824
12        KNOWL EVACUATION PROCEDURES                                                 091825
13        MP NA                 MS NA                                                 091826
14   SUBT EVACUATE DITCHED AIRCRAFT                                                   091827
15   MFTN EVACUATE SURVIVAL EQUIPMENT                                                 091828
15   MFTN EVACUATE LIFE RAFT                                                          091829
15   MFTN EXIT AIRCRAFT                                                               091830
15   MFTN PULL LIFE RAFT RELEASE HANDLES                                              091831
15   MFTN POSITION SEAT SO AS NOT TO BLOCK COPILOT EXIT                               091832
```

Figure 3. Example of a Task Analysis Computer Printout Sheet.

DESCRIPTIVE ELEMENTS. Each data element which added descriptive information to function or task descriptions is defined separately below. Abbreviations in parentheses identify the element codes which were keypunched. They are presented to facilitate interpretation of the resulting card decks and computer printouts.

Date (D) A six digit entry was used to identify the month, day and year in which the task data were completed.

System (S) A maximum of seven characters was used to identify the specific weapon system to which the task data apply (e.g., FB-111A).

Mission Type (MN) This entry contained a textual description of the type of mission considered for the weapon system to which the task data apply. Mission types were selected from the set contained in table 4. The entry (P) showed mission phase (see table 2).

Table 4. Mission Types.

Combat Air Drop	Recon
Strategic Weapon	Air Superiority
Tactical Weapon	Perimeter Patrol
Refueling	

Function Number (FN) This entry was a two-digit number derived from the standardized task catalog.

Function Description (FUNC) A function is a broadly defined system activity contributing to mission performance. This entry contained a textual description of the function associated with the function number identified above. This entry also was derived from the standardized task catalog.

Task Number (TN) Task numbers were three-digit entries derived from the standardized task catalog.

Entry Number (ENT) Entry number was a sequential three-digit number used for numbering tasks for each weapon system. It was primarily a data control entry.

Time (TIME) Task time was estimated in minutes and tenths of minutes.

Task (TASK) A task is a unit of work performed by the navigator in order to accomplish a function-level requirement. This entry contained a textual description of the task associated with the task number identified above. It was derived from the standardized task catalog and was designed to identify

a unit of work performed by the navigator within a function.

Information Source (SRCE) This entry contained a textual description of the basic sources of the task analysis information. Interviews, Technical Order documents, checklists, specifications, other task analyses and other applicable sources were identified.

Task Initiating Conditions (TICN) This entry contained a textual description of the general stimulus conditions which trigger the requirement for the navigator to perform the task.

Task Alternatives (TALT) This entry identified other tasks which could be substituted in case malfunction or environmental factors precluded accomplishment of the requisite task. Many such entries were addressed more exhaustively within the Emergencies mission phase. In this phase, typical emergency and contingency tasks were identified and analyzed for each weapon system.

Subtask Number (SN) This entry was a three-digit number derived from the standardized task catalog.

Subtask (ST) A subtask is a sub-goal associated with or required for the accomplishment of a task-level behavioral requirement. This entry contained a textual description of the subtask associated with the subtask number identified above. Subtasks are sub-goals associated with the achievement of a task objective. Subtask entries also were made for alternative yet primary means of accomplishing task-level objectives.

Subtask Time (T) The time required to accomplish each subtask was estimated in minutes and tenths of minutes. For continuously performed subtasks, such as monitoring communications, relatively short subtask times were used in conjunction with a coded entry (99) for frequency of occurrence. The coded entry identified continuous subtask performance.

Subtask AFSC (SC) The appropriate four-digit navigator AFSC was entered to identify which of the four flying specialties was involved in accomplishing the subtask within the context of the weapon system being considered.

Frequency of Occurrence (FR) During data collection and validation interviews with operational navigators, estimates of the number of times a subtask was performed within each mission phase were obtained. These estimates were entered, with the maximum frequency being 9[illegible]. Because both missions and mission phases can vary in both complexity and duration, this entry may be considered only an estimate.

System (SYS) This textual entry identified the general aircraft system which would be used to accomplish the subtask. System entries were selected from a standard set shown in Table 6. Multiple entries could be made.

Table 6. System Categories.

Document	Communications
Sensor	Navigation
Life Support	Weapon
Electrical	Penetration
Reconnaissance	Flight Control

Hardware (HDW) This textual entry contained a more definitive description of the hardware type associated with the system entry identified above. For example, a system entry might be "navigation". A hardware entry might be "radar" or "BNS computer."

Hardware Number (NO) When applicable, specific hardware designations were entered for the hardware item identified immediately above. Multiple entries could be made.

Microfunction (MFTN) Microfunctions were defined as functionally oriented clusters of procedural steps. The microfunction entry was created specifically for this analysis and was designed to be in keeping with the functional orientation applied to the task descriptive process.

ANALYSIS ELEMENTS. Analysis information added to the task descriptive information is identified below. Analysis, to a great extent, takes one of two extreme avenues. Either tasks are highly analyzed in experimental laboratories, or they are analyzed by means of "expert judgments." The latter approach was used in the present study. In order to ensure the best possible quality of the analysis information, instructor navigators were requested to assist in making many of the analysis decisions during visitations to operational units. Additionally, attempts were made to structure the content of microfunction data to provide a cueing function for the identification of knowledge and skill analysis items.

Criticality (CR) Each subtask was rated for criticality in keeping with the scale shown in table 7.

Difficulty to Perform (DP) Each subtask was rated for difficulty in keeping with the scale shown in table 8.

Difficulty to Learn (DL) The relative difficulty which a representative student navigator might experience in learning each subtask to proficiency was rated in keeping with table 9. It must be pointed out that this rating was made outside of any particular training context, and must be considered only as a crude approximation.

Table 7. Criticality Scale.

Levels	Description
1	Of no direct consequence to achieving mission objectives.
2	Of possible but small consequence to achieving mission objectives.
3	Would result in degraded mission performance, but would not result in loss of life or aircraft.
4	Of probable serious consequence and would result in an aborted mission.
5	Would result in aborted mission, but typically would not result in loss of life or aircraft.
6	Would result not only in aborted mission, but very probably in loss of life and aircraft.

Table 8. Performance Difficulty Scale.

Levels	Description	Example
1	Highly proceduralized chains of behavior. Require only identification of relevant work items and execution of proceduralized steps.	Activation or tuning of radio.
2	Proceduralized chains of behavior including defined alternative branches and the selection of appropriate branches. Involves identification of more complex cue patterns than Level I.	Checkout procedures where acceptable levels of operations must be determined.
3	Requires the use of concepts and abstractions of the immediate environment.	Interpreting a symbolic display such as radar or performing routine navigational tasks.

Table 8. (Continued).

Levels	Description	Example
4	Requires the use of principles and abstractions of the immediate environment for problem solving and decision making, implying multiple information sources and mental data processing.	Performing non-routine navigational tasks, signal analysis, stores management.

Table 9. Learning Difficulty Scale.

Levels	Description	Example
1	Simple proceduralized behavior of proceduralized chains of behavior.	Sequentially link communication channels, checklists.
2	Multiple or singular stimuli, leading to multiple or singular response.	Collect wind, ground speed, fuel data, etc., and transmit position report.
3	Requires the use of concepts and abstraction intervening between a single stimulus and a single response.	Weather radar scope interpretation.
4	Requires the use of principles, abstraction, and calculations intervening between a multiple stimulus and a multiple response.	Air-to-Air radar intercept.

Training Device (TD) A primary means of training the skills and knowledges required to perform each subtask was determined using the scale shown in Table 10. The ratings were means to reflect a primary device for training, not the only device. It also must be pointed out that these ratings had to be made outside the context of any particular training program and for each subtask in isolation. They were only estimates.

Knowledge Level (KNOWL) This entry contained textual descriptions of knowledges required to accomplish subtasks.

Table 10. Training Device Categories.

1	Text	5	Part-Task Simulator
2	Instructor	6	Full-Task Simulator
3	Audio Visual	7	Inflight
4	Procedures Trainer		

Measurement Parameter (MP) In this entry, recommendations were made for parameters to be measured to determine successful completion of subtask performance requirements.

Measurement Standard (MS) In this entry, standards for successful completion of subtask requirements were identified to the extent possible. In accomplishing both the MP and MS analyses, use was made of available documented information, content from interviews with instructor navigators, and analysis of performance requirements by members of the analysis team. The entire area of navigator (or other human) performance measurement, however, continues to remain a topic requiring much additional research.

Skill Level (SKILL) This entry contained textual descriptions of skills required to accomplish subtasks. A somewhat broader definition of skill was used in order that the entries would not be limited to the traditional psychomotor or motor skills.

Measurement Device (MD) Recommendations for the general type of device for measuring subtask-level performance were made in keeping with the gross scale shown in Table 11. These recommendations also were made outside the context of any particular training program and individually for subtasks in isolation.

Table 11. Measurement Device Categories.

Categories	Description	Examples
1	Discrete sampling of parameters at a point in time which will determine the accomplishment of necessary events.	Control positioning, decision making or identifying relevant information.
2	Discrete sampling of parameters at multiple points in time to determine the accomplishment of multiple or sequential events.	Cursor positioning, voice communication, operation of penetration aids.
3	Discrete sampling of system state variables at a point in time to determine accomplishment of total weapon system conditions.	ETA at checkpoints, position errors at weapon release, determine present position.
4	Continuous sampling of system state variables to measure continuing trends to remain within standard.	Monitor flight path. Monitor engine performance, direct air-to-air intercept.

DATA COLLECTION METHODOLOGY

The fundamental steps used to implement the requirements for the commonality analysis through the collection and validation of formatted task analysis data are as follows:

- Develop the preliminary task catalog, as discussed previously under the subsection titled Catalog Development.
- Complete preliminary task analysis forms in preparation for data collection visits.
- Interview instructor navigators for operational systems to discuss content of task analysis forms and collect additional information.
- Update task catalog and pursue completion of the task analysis forms.
- Interview instructor navigators for operational systems or with other personnel for R&D systems to complete and validate content of task analysis forms.
- Cleanup and keypunch task analysis data.
- Complete computer commonality analysis of task data.

Two series of trips were accomplished to ensure that all task description and analysis information comprehensively and validly reflected requisite navigator operational task requirements. The trips are summarized in Table 12.

The first series emphasized data collection, simulator observations and inflight observations when possible. In order to maximize the probability of collecting relevant information, preliminary task analysis sheets were prepared and taken on each data collection visit. This was done to provide structure to the interviews rather than approaching them in a loose, open-ended fashion.

A primary objective during data collection visits was to obtain information which could be used to further develop the task catalog. A second objective was to obtain information of relevance to other descriptive elements of the analysis. A third objective was initially to refine the many rating scales used and subsequently to make ratings using the scales.

Two systems in the NOUFFSS sample are not yet operational. Information dealing with AWACS navigator tasks was obtained through the AWACS SPO, L.G. Hanscom Field, Bedford, Mass. Information dealing with the B-1 was obtained from study documents received from the B-1 SPO, Wright-Patterson Air Force Base, Ohio and through interviews with personnel of the North American Rockwell Corp., Los Angeles, California.

Table 12. Data Collection and Validation Trips.

System	Data Collection	Data Validation
KC-135A	March AFB Riverside, CA	March AFB Riverside, CA
FB-111A	Mather AFB Sacramento, CA	Carswell AFB Ft. Worth, TX
B-52G	Mather AFB Sacramento, CA	Mather AFB Sacramento, CA
F-4E	George AFB Victorville, CA	George AFB Victorville, CA
F-111A	Nellis AFB Las Vegas, Nev.	Nellis AFB Las Vegas, Nev.
RF-4C	Bergstrom AFB Austin, TX	Bergstrom AFB Austin, TX
C-130E	Pope AFB Fayetteville, NC	Pope AFB Fayetteville, NC
C-141A	Norton AFB San Bernardino, CA	Norton AFB San Bernardino, CA
C-5A	Charleston AFB Charleston, SC	Travis AFB Fairfield, CA
B-1A	B-1A SPO	North American Rockwell Los Angeles, CA
AWACS	AWACS SPO	- - -

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SECTION III

COMMONALITY ANALYSIS REQUIREMENTS

DEFINITION AND BACKGROUND

As used in the NOUFFSS study, commonality analysis is a methodology applied to task analysis data to indicate the relative number (percent) of individuals (navigators) within particular sets of individuals (all navigators, Radar Navigators only, Electronic Warfare Officers only, etc.) who perform various subtasks. The NOUFFSS commonality analysis, therefore, was simply a statistical treatment of task analysis data in order to determine the relative numbers of navigators who presently perform or will be required in the future to perform various subtasks.

To-date, the few commonality analyses which have been performed have dealt with the establishment of training requirements. Future Undergraduate Pilot Training Program studies (e.g., Ref. 6) performed commonality analyses for the purpose of identifying training course content and trainer aircraft requirements. A recent analysis of training requirements for the Air Force A-7 aircraft also employed commonality analysis concepts for the purpose of establishing common training method requirements (Ref. 7). Only one prior commonality analysis has involved computer treatment of task data (Ref. 6).

Methodological concepts and requirements for commonality analysis were first introduced by Semple and Majesty in 1969 (Ref. 5). Building upon the basic concepts, the Northrop Corp. in 1970 completed the first computer-based analysis of task commonalities across a diverse sample of aircraft missions and aircrew positions (Ref. 6). The analysis was accomplished in the context of a Future Undergraduate Pilot Training (FUPT) study.

The FUPT commonality analysis was based upon projected percents of pilots to be assigned to a preselected sample of aircraft. In the FUPT study, the sample of aircraft was subdivided into categories. Categories were defined as groups of aircraft estimated to be similar with respect to the tasks which the pilots would be required to perform. Task commonality weighting factors were then determined based upon projected pilot requirements for each category of aircraft during the 1979-1981 timeframe. The weighting factors were derived from projected average numbers of new pilots required per year during the 1979-1981 timeframe for aircraft in each of the separate categories, divided by projected average numbers of new pilots required per year in all categories, multiplied by 100 (i.e., a percent). Through a series of computer-based procedures, commonality weighting factors were combined and evaluated against preselected commonality criteria to segregate common from non-common tasks.

A similar, but not identical, procedure was developed for use in NOUFFSS Phase II. The NOUFFSS procedure is described in the following pages.

Prior to NOUFFSS data validation visits, task analysis sheets were brought up-to-date. Information and documentation obtained during the first visits were reviewed and numerous microfunction and analysis data added. Because of extensive catalog changes which were necessary during the early months of Phase II, data validation visits also doubled as data collection opportunities for significantly restructured tasks and subtasks.

Analysis elements were completed during and immediately following the second visits. In particular, attempts were made to identify relevant performance measurement parameters and standards. Rapidly paced interviewing historically has proved to be a poor source of measurement information. NOUFFSS Phase II proved to be no exception to this rule. In many cases, measurement parameter information simply does not exist. Every navigator cannot be expected to be an expert in sophisticated performance measurement. They cannot be expected to gain the necessary expertise during one to two day interviews. Nonetheless, valuable measurement-related information was obtained, thus better equipping the analysis team to make estimates of performance parameters and standards.

Following data validation visits, task data for each weapon system was subject to clerical review in order to eliminate errors and inconsistencies which inadvertently are incorporated into any large body of data. Renumbering of all functions, tasks and subtasks was accomplished during the last month of Phase II, and the remaining analysis elements were completed. All data were then submitted for keypunching and verification. Section VIII presents card formats used in keypunching the Task Analysis data.

One of the final activities was the preparation of the commonality software. Following software debugging, data decks were prepared and the program was exercised.

COMMONALITY ANALYSIS CONCEPTS

Introduction. The commonality analysis was built around four basic concepts. A fundamental understanding of the concepts is preprequisite for understanding the methodology. Each concept is addressed below.

The first concept deals with time intervals. The total 1971-1990 timeframe was subdivided into four intervals of five years each. Weapon system projections through 1990 were developed during Phase I of the NOUFFSS study (Ref. 2). Numbers of navigators for each crew position in each of the 11 weapon systems also were projected through 1990. Examination of these projections indicated that trends remained relatively stable over five-year blocks of time. Accordingly, the data were averaged over the five-year spans comprising the four intervals. The four blocks of time were: 1971-75, 1976-80, 1981-85, and 1986-90. Although the averaging did obscure some minor variations, examination showed that use of other time period increments produced essentially the same results.

Separate commonality analyses were performed within each of the four time intervals. No analysis was performed across all intervals (i.e., the full 1971-1990 period). Such an analysis would have required averaging over too many changes in force structure composition. Furthermore, it is possible to manually average commonality weighting factors across any of the intervals if one wishes to do so. Therefore, the basic data generated during the commonality analysis provides the flexibility for other, manually accomplished commonality analyses.

The second concept is that two types of commonality sorts were performed. The first type was an "all inclusive sort." In this sort, task data for all weapon systems and all navigator positions were used. Commonality analysis information derived from an "all inclusive sort" represented the complete study sample. With certain qualifications, this information may be generalized to the total navigator field.

The second type of sort addressed each of the four navigator AFSCs separately. This is referred to as a "within sort" because task data for crew positions within each AFSC were analyzed separately for each of the four AFSCs. For example, a "within sort" was performed just upon task data for all Radar Navigators (AFSC 1525). This analysis used task data for the B-52G RN, the B-1A RN and the FB-111A RN. All other task data were excluded from this analysis.

The third concept involves the coding of aircraft-crew position combinations. Of the 11 weapon systems in the NOUFFSS sample, two (B-52 and B-1) require more than one navigator in their crews. Within the weapon system sample, a total of 14 aircraft/AFSC crew position combinations exist. Task data were developed for each of the 14 positions. For the commonality analyses, each of the aircraft/AFSC position combinations was assigned a number code ranging from one through 14 inclusive. Classified Section IX of Phase II, located in Appendix I, identifies which crew position in which aircraft corresponds with each number code (Ref 9).

To facilitate interpretation of the commonality analysis methodology, the aircraft/AFSC position codes are clustered according to AFSC below.

AFSC	Aircraft-Crew Position Code Clusters
1575 (EWO)	1 and 2
1555 (WSO)	3 and 4
1525 (RN)	5, 6 and 7
1535 (NAV)	8 through 14

All commonality sorts were based upon aircraft/AFSC position codes. For the "all inclusive sorts", task data for all 14 aircraft/AFSC positions were analyzed. For "within sorts", only task data associated with the appropriate clusters of codes were analyzed. For example, a "within sort" to identify subtasks which are common or non-common just within the Weapon System Officer (AFSC 1555) category was accomplished by instructing the computer to analyze data only for aircraft/AFSC codes 3 and 4.

The fourth concept is that all commonality weighting factors are simply percents. Derivation of weighting factors is addressed fully in the next subsection.

DEVELOPMENT OF COMMONALITY ANALYSIS WEIGHTING FACTORS

Introduction. All commonality weighting factors were developed for application to subtask-level data. This was done for two reasons. First, subtasks are the most descriptive yet standardized level of job description. Second, if a subtask is common (or non-common), then it follows that the task under which it is performed also may be considered common (or non-common). Addressing commonality at the task level, on the other hand, would provide no information regarding the commonality of individual subtasks.

There are legitimate requirements for weighting subtasks. If subtask "A" is performed by a navigator in weapon system #1, and subtask "B" is performed by a navigator in system #2, but

there are two times as many systems #1 as systems #2, then this must be taken into account. Similarly, if the number of navigators required for system #2 is greater than the number required for system #1, this, too, must be taken into account. Commonality weighting factors developed for NOUFFSS Phase II considered both of these factors.

Commonality analysis weighting factors were developed separately for each of the four time intervals comprising the total 1971-1990 timeframe. The projected numbers of navigators required for each system were used as basic data for developing the weights.

Within each five-year time interval, separate sets of weighting factors were required for the "all inclusive sorts" and each of the four "within sorts."

The same basic data and the same basic procedure were used to develop all commonality weighting factors. The procedure was based upon the premise that training content and course structure should reflect not only operational job requirements, but also the relative numbers of navigators required to perform various job elements (subtasks).

Basic Data and Basic Procedure. The basic data from which all commonality weights were derived was a table showing the projected average number of individuals required for each of the 14 aircraft/AFSC position combinations during each five-year time interval. The projections were derived during NOUFFSS Phase I (Ref. 2). The data were developed from information on the projected weapon system inventory and requirements for navigators in each weapon system in the NOUFFSS sample. Projections were developed for each year through 1990. The data were then averaged over the five years within each of the four time intervals.

The basic procedure was to convert numbers of individuals projected for each of the 14 aircraft/AFSC combinations to percent values. Percentages, rather than counts of navigators, were used as weighting factors for several reasons. First, percentages are ratio scale data. As such, they can be legitimately added, subtracted, multiplied and divided without losing their inherent meaning. Second, the extremes of the percent scale (0% and 100%) are fixed values, thus providing a finite scale. Third, percentages may be used to make relative statements about commonality which may be applied to any size navigator force. Simply stating actual numbers of navigators as weighting factors would be meaningful only as long as the total navigator force size remained constant. Fourth, in the NOUFFSS study, only a sample of all weapon systems and navigator positions was used. It is desirable, however, to be able to generalize from the sample to the entire population. This can be far more effectively accomplished through the use of percentages. Finally, percentages

have inherent meaning, whereas counts of navigators do not have inherent meaning. Without inherent meaning, generalizing is not possible. For example, if it were known that 343 navigators performed a particular subtask, what would this mean in relationship to the total navigator force? On the other hand, if it were known that 343 out of a total force of 3,000 (11.4%) performed a subtask, then the information could be generalized beyond the sample. The only assumption underlying the percentage weighting factor approach is that the NOUFFSS sample is representative of the total navigator population. This, however, is a requirement for validly generalizing any sample data.

Procedure for All Inclusive Sorts. The derivation of weighting factor percentages for the "all inclusive sorts" was very straightforward. First, the total projected navigator force for the NOUFFSS sample was determined by totaling the number of navigators projected for each of the 14 aircraft/AFSC combinations. Separate totals were determined for each of the four time periods. The numbers of navigators for each of the 14 positions were then simply expressed as percentages of the totals within each of the four time periods. Resulting percentages weighting factors are shown in Table 13.

Procedure for Within Sorts. The same fundamental procedure was used for deriving the "within sort" commonality weighting percentages. Again, weighting factors were determined separately for each of the four time intervals.

Because each "within sort" addressed only one AFSC category at a time, it was first necessary to determine subtotals of navigator counts separately for each of the four AFSC subsets comprising the total sample. This was accomplished by subtotaling the projected number of AFSC 1525 Radar Navigators separately, subtotaling the projected number of AFSC 1535 Navigators separately, etc. The projected numbers of navigators for each of the aircraft/AFSC positions which contributed to each of the subtotals were then simply expressed as a percentage of that subtotal. This is the equivalent of saying that the total navigator sample was subdivided into four smaller samples. The "within sort" weights were then derived separately for each of the four smaller samples. Resulting percentage weighting factors are shown in Table 14.

Hypothetical Computation Examples. The following commonality weighting factor computation examples are presented to clarify the computation procedure. All computations are based upon hypothetical, fictitious data and information. Actual data and information could not be used due to security classification.

The first example addresses the computation of weighting factors for an "all inclusive sort" across all 14 aircraft/AFSC positions. This procedure was employed to develop commonality weights for each of the four time periods. For this example, however, the 1971-1975 period is assumed.

Table 13. Commonality Weighting Criteria for "All Inclusive" Commonality Analyses.

Aircraft/ AFSC Codes	TIME PERIODS			
	1971-75	1976-80	1981-85	1986-90
01	08	06	01	00
02	00	01	03	10
03	20	19	15	00
04	05	05	07	18
05	08	06	01	00
06	01	02	02	01
07	00	01	03	10
08	08	06	01	00
09	13	14	19	17
10	05	05	06	00
11	19	21	23	22
12	10	10	13	07
13	03	03	04	12
14	00	01	02	03

Table 14. Commonality Weighting Criteria for "Within" Commonality Analyses.

Aircraft/ AFSC Codes	TIME PERIODS 1971-75	1976-80	1981-85	1986-90
01	99	86	18	00
02	00	14	82	99
03	80	78	68	00
04	20	22	32	99
05	86	75	13	00
06	14	14	26	06
07	00	11	61	94
08	13	11	01	00
09	22	23	29	28
10	08	08	09	00
11	34	35	33	35
12	18	17	19	12
13	05	05	06	19
14	00	01	03	06

The first requirement is to identify the meaning of the specific aircraft crew positions associated with each of the 14 aircraft/AFSC codes. This information is shown in Columns A and B of Table 15. In the table, aircraft/AFSC Code 01 is the F-4E Weapon System Officer (AFSC 1555). Assume that there are 1,000 F-4E aircraft in the projected 1971-1975 inventory. Further assume that an average of 3.5 Weapon System Officers are required for each F-4E. This means that a total of 3,500 F-4E Weapon System Officers are required. This figure is shown in Column C of Table 15. The remainder of Column C presents projected numbers of navigators required for the remaining 13 aircraft/AFSC positions. The sum of all numbers in Column C (53,000 navigators) is the total number of navigators in the force structure comprising the NOUFFSS weapon system sample. This number (53,000) is the denominator of the weighting factor ratio used to derive commonality weights for all 14 aircraft/AFSC positions.

Weighting factors are determined by the ratio of the number of navigators for each aircraft/AFSC position (numerator) to the total number of navigators in the sample force (denominator). Column D presents these ratios for each of the 14 aircraft/AFSC positions. When calculated as a decimal equivalent and multiplied by 100, the ratios are translated into percentages. Corresponding percentages for each of the 14 aircraft/AFSC positions are shown in Column E. Commonality weighting factors are shown in Column F. A comparison of Columns E and F reveals that the data entries are identical. This is because the commonality weighting factors <u>are</u> percentages.

The second example addresses the computation of weighting factors for a "within sort" commonality analysis. For a "within sort", separate groups of weighting factors were required for each of the four navigator AFSCs. For the purpose of this example, a "within sort" for AFSC 1525 (Radar Navigator) is assumed.

Proceeding in the same manner as in the previous example, it is first necessary to determine which of the 14 aircraft/AFSC positions are Radar Navigators. This information is shown in Columns A and B of Table 16. The same information is contained in Columns A and B of Table 15. The information is the same because aircraft/AFSC codes are always the same regardless of the type of commonality sort being accomplished. There are only three AFSC 1525 aircraft-crew position combinations in the NOUFFSS sample.

The next step is to identify the projected numbers of Radar Navigators required during the 1971-1975 time period for each of the three aircraft/AFSC positions which are filled by Radar Navigators. These data are shown in Column C of Table 16. Column C of Table 15 contains the same numeric information as Column C of Table 16 for the three aircraft/AFSC positions of interest. It should be noted that no radar navigators (a zero entry) has been made for aircraft/AFSC position 03. This position

Table 15. Fictitious Example of the Computations of Commonality Weighting Factors for the "All Inclusive" AFSC Sort.

Col. A	Col. B		Col. C	Col. D	Col. E	Col. F
Aircraft/ AFSC Codes	Fictitious Meanings of Codes		Fictitious # of Navigators for Each Code	Ratio: # Nav. Per Crew Position/Tot. Nav. in Force	% of Total # of Navs.	Fictitious Weighting Factors, Time Period 1971 - 1975
01	F-4E	WSO	3,500	3,500/53,000	07	07
02	F-111A	WSO	1,000	1,000/53,000	02	02
03	B-1A	RN	0	0/53,000	00	00
04	B-52G	RN	5,000	5,000/53,000	09	09
05	FB-111	RN	3,000	3,000/53,000	06	06
06	C-5A	NAV	2,000	2,000/53,000	04	04
07	C-141A	NAV	4,000	4,000/53,000	07	07
08	RF-4C	NAV	1,500	1,500/53,000	03	03
09	B-52G	NAV	10,000	10,000/53,000	19	19
10	AWACS	NAV	1,000	1,000/53,000	02	02
11	KC-135	NAV	9,000	9,000/53,000	17	17
12	C-130E	NAV	3,000	3,000/53,000	06	06
13	B-52G	EWO	5,000	5,000/53,000	09	09
14	B-1A	EWO	5,000	5,000/53,000	09	09
Total:			53,000 Navs. (All AFSCs)		100%	

Table 16. Fictitious Example of the Computations of Commonality Weighting Factors for Sorts Within AFSCs.

Col. A	Col. B	Col. C	Col. D	Col. E	Col. F
Aircraft/ AFSC Codes	Fictitious Meanings of Codes	Fictitious # of Navigators for Each Code	Ratio: Nav. Per Crew Position/Tot. Nav. in Force	% of Total # of Navs.	Fictitious Weighting Factors, Time Period 1971 - 1975
03	B-1A RN	0	0/8,000	00	00
04	B-52G RN	5,000	5,000/8,000	62	62
05	FB-111 RN	3,000	3,000/8,000	38	38
Total:		8,000		100%	

is the B-1A Radar Navigator. The zero entry in the fictitious example reflects the fact that no B-1A weapon systems are projected for the force in the 1971-1975 time period. Hence, no B-1A Radar Navigators are shown for this period. The remainder of Column C in Table 16 presents the number of Radar Navigators required for the remaining two aircraft/AFSC positions. The sum of all numbers in Column C (8,000) is the total number of Radar Navigators in the force structure comprising the NOUFFSS sample. This number (8,000) is the denominator of the weighting factor ratio used to derive commonality weights for the Radar Navigator (AFSC 1525) subset of total aircraft/AFSC sample.

Weighting factors are determined by the ratio of the number of Radar Navigators for each of the three aircraft/AFSC positions (numerator) to the total number of Radar Navigators in the AFSC 1525 subset. Column D of Table 16 presents these ratios. When calculated as a decimal equivalent and multiplied by 100, the ratios are translated into percentages. Corresponding percentages for each of the three Radar Navigator aircraft/AFSC positions are shown in Column E. Commonality weighting factors for the "within sort" for the AFSC 1525 subset are shown in Column F. A comparison of Columns E and F reveals that the data entries are identical. This, again, is because the commonality weighting factors <u>are</u> percentages.

IMPLEMENTING THE COMMONALITY ANALYSIS

Basic Commonality Analysis Procedures. All commonality analyses were performed by a computer. The computer-based commonality analysis procedures involved three primary elements: the sequencing and use of task analysis data; the identification and application of appropriate commonality weighting factors; and organization of the computer printout for 20 separate commonality analyses.

All commonality analysis data were input to the computer and output by the computer in numeric form. Function, task and subtask numbers identifying the functions, tasks and subtasks performed by each of the 14 aircraft/AFSC positions were input to the computer. The number equivalents for each function, task and subtask are shown in Section V. Tables of precomputed commonality weighting factors for the 20 separate commonality analyses also were input.

Using the numerically coded task analysis data, the computer arranged all function numbers in ascending order from smallest to largest. Then, task numbers within each function were arranged in ascending order from smallest to largest. Similarly, subtasks numbers within each task also were arranged in ascending order. In this manner, the computer sequenced the function, task and subtask numbers of the computer output to correspond with the sequence of functions, tasks and subtasks in the basic task catalog (Section V).

The computer first determined which of the 20 "within AFSC" or "all inclusive" commonality sorts it was to perform. It then used task analysis data and commonality weights appropriate only for the aircraft/AFSC positions and the time period of interest for the commonality sort. For example, for a "within AFSC" sort to be performed only on Weapon System Officer (AFSC 1555) tasks, the computer used task data only for aircraft/AFSC positions 3 and 4. Task data for all other positions were ignored. Next, the computer determined which of the four time periods correspond with the particular commonality sort and selected the appropriate table of commonality weighting factors to be used for the analysis.

All commonality analyses were performed on subtask data. Starting with the first subtask (e.g., number 001), the computer determined which of the aircraft/AFSC positions of interest performed the subtask. For those which performed the subtask, it applied the appropriate commonality weighting factors. It then totalled all weighting factors across all relevant aircraft/AFSC positions. Finally, it tested the total commonality weight against three preselected commonality criteria. When this had been accomplished, the procedure was repeated for the next subtask (e.g., number 002). Subsequent subtasks were addressed until all subtasks had been exhausted. At this point, the computer cycled into the next of the 20 commonality analyses, repeating the above procedure until all 20 analyses had been completed.

A computer printout was made for each of the subtask-level commonality tests in each of the 20 different commonality analyses. The next section deals with reading the commonality analysis output. Detailed information and flow charts of the computer procedure are presented in Section VI.

Reading the Commonality Analysis Output. The commonality analysis computer output was subdivided into 20 sections, with one section for each of the 20 different commonality analyses. Each section was titled, and pages were numbered consecutively within each section.

Each section presented commonality data for a particular commonality sort within one of the four time periods. Because there were five sorts and four time periods, there were 20 commonality analyses. For example, section 1 presented data for a "within sort" for AFSC 1575 (Electronic Warfare Officers). Only task data for aircraft/AFSC crew positions 1 and 2 were used for this commonality sort. Furthermore, the time period of interest was 1971-1975. Table 17 identifies the content and time periods for each of the 20 commonality analysis sections. The second and fourth lines of the title for each section of the printout identified the time period and aircraft/AFSC positions of interest for the analysis.

Table 17. Content of Commonality Analysis Computer Printout Sections.

Section	Sort Type	Aircraft/ AFSC Codes	AFSCs of Interest	Time Period
1	*W	1 & 2	1575	1971-75
2	W	3 & 4	1555	1971-75
3	W	5, 6 & 7	1525	1971-75
4	W	8 - 14	1535	1971-75
5	**AI	All 14	All	1971-75
6	W	1 & 2	1575	1976-80
7	W	3 & 4	1555	1976-80
8	W	5, 6 & 7	1525	1976-80
9	W	8 - 14	1535	1976-80
10	AI	All 14	All	1976-80
11	W	1 & 2	1575	1981-85
12	W	3 & 4	1555	1981-85
13	W	5, 6 & 7	1525	1981-85
14	W	8 - 14	1535	1981-85
15	AI	All 14	All	1981-85
16	W	1 & 2	1575	1986-90
17	W	3 & 4	1555	1986-90
18	W	5, 6 & 7	1525	1986-90
19	W	8 - 14	1535	1986-90
20	AI	All 14	All	1986-90

*W is "Within AFSC" commonality analysis.
**AI is "All Inclusive" commonality analysis.

Data columns were labeled at the top of each page of computer printout (see Figure 4). Reading from left to right, column titles were: function number; task number; subtask number; aircraft/AFSC code numbers (1 through 14); value sum; and criteria checks.

The first three columns identified the number codes of functions, tasks and subtasks which were considered in the various commonality analyses. A complete description of the titles associated with each number code may be obtained by cross indexing the function, task and subtask numbers with the content of the task catalog (Section V).

Not all function, task or subtask numbers appeared in each of the 20 commonality analyses. This was particularly true for "within AFSC" commonality analyses. If none of the aircraft/AFSC positions within a particular commonality analysis performed a particular subtask, then that subtask's number code was not included in the computer printout. Similarly, if none of the aircraft/AFSC positions performed any of the subtasks associated with a particular task, then the number code for the task also was deleted from the printout. If none of the tasks within an entire function was performed, then the number code of the function also was deleted.

For example, subtask number 395 did not appear in section 8. Section 8 was a "within AFSC" commonality analysis for Radar Navigators (AFSC 1525) only. The title for subtask number 395 is: "Prepare escape mechanism for ditching." It may be concluded, therefore, that none of the Radar Navigators in the NOUFFSS sample perform this particular subtask. Also, both functions 21 and 22 are missing from section 8. The title for function 21 is: "Execute air-to-air search and surveillance procedures." The title for function 22 is: "Execute intercept operations." Both of these functions apply only to the Weapon System Officer (AFSC 1555) and to the air intercept mission. These functions, therefore, legitimately were not included in section 8 because section 8 applied only to AFSC 1525.

Individual commonality weights were presented for each subtask. The commonality weights were presented directly under each aircraft/AFSC number code (01 through 14). Only two types of entries were made.

The primary type of entry was a number ranging from 0 through 99. These numbers were the commonality weights. The appearance of a commonality weight number indicated only two things. First, it indicated that the aircraft/AFSC position under which it appeared performs the particular subtask. Second, it showed the percent of the total number of all crew positions of interest which that particular aircraft/AFSC position comprised.

YEAR SPAN FOR THIS SECTION 1976 TO 1980 9/13/71 SECTION 10 PAGE 4

FUNCTION NO.	TASK NO.	SUBTASK NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	VALUE SUM	CRITERIA OMKS 30	50	70
			CODED AIRCREW NUMBER AND ASSOCIATED VALUE																	
		100	-0-	-0-	19	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	19	-0-	-0-	-0-
		101	-0-	-0-	19	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	19	-0-	-0-	-0-
		102	-0-	1	-0-	-0-	-0-	2	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	8	-0-	-0-	-0-
		103	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	1	-0-	-0-	-0-
		104	-0-	-0-	19	-0-	-0-	2	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	26	-0-	-0-	-0-
6	24	105	-0-	-0-	19	5	-0-	2	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	31	**	-0-	-0-
		106	-0-	-0-	19	5	-0-	2	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	31	**	-0-	-0-
	25	107	-0-	1	19	-0-	-0-	-0-	1	-0-	14	5	-0-	10	3	1	54	-0-	**	-0-
	26	108	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-	21	10	3	1	36	**	-0-	-0-
		109	-0-	-0-	19	5	-0-	2	1	-0-	-0-	5	21	-0-	-0-	-0-	53	-0-	**	-0-
		110	-0-	-0-	19	5	-0-	2	1	-0-	-0-	5	-0-	-0-	-0-	-0-	32	**	-0-	-0-
		111	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	1	-0-	-0-	-0-
	27	112	-0-	1	-0-	-0-	-0-	2	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	4	-0-	-0-	-0-
		113	-0-	-0-	19	5	-0-	-0-	-0-	-0-	14	5	21	10	-0-	1	75	-0-	-0-	**
		114	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	3	-0-	3	-0-	-0-	-0-
		116	-0-	-0-	-0-	-0-	6	-0-	-0-	-0-	14	5	21	10	-0-	1	57	-0-	**	-0-
		117	-0-	-0-	19	-0-	6	-0-	-0-	-0-	14	5	21	10	-0-	1	76	-0-	-0-	**
		118	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	10	-0-	-0-	10	-0-	-0-	-0-
		119	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	3	-0-	3	-0-	-0-	-0-
		120	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	21	-0-	-0-	-0-	21	-0-	-0-	-0-
	28	121	-0-	-0-	19	5	6	2	1	-0-	14	5	21	10	3	1	87	-0-	-0-	**
		122	-0-	-0-	-0-	-0-	-0-	2	1	-0-	-0-	5	-0-	-0-	-0-	-0-	8	-0-	-0-	-0-
		123	-0-	-0-	-0-	-0-	-0-	2	1	-0-	14	-0-	21	10	3	1	52	-0-	**	-0-
		124	-0-	1	19	5	-0-	2	-0-	-0-	-0-	5	-0-	-0-	3	1	36	**	-0-	-0-
		125	-0-	-0-	19	5	-0-	-0-	1	6	14	5	-0-	10	3	1	64	-0-	**	-0-
		126	-0-	1	-0-	-0-	-0-	2	-0-	6	-0-	-0-	-0-	-0-	-0-	-0-	9	-0-	-0-	-0-
		127	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-
	29	128	-0-	1	19	-0-	-0-	2	-0-	-0-	14	5	-0-	-0-	-0-	1	42	**	-0-	-0-
		129	-0-	1	-0-	5	-0-	2	-0-	6	14	-0-	21	-0-	3	-0-	52	-0-	**	-0-
		130	-0-	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-
		131	6	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	6	-0-	-0-	-0-
		132	6	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	6	-0-	-0-	-0-
	30	133	-0-	1	-0-	5	-0-	-0-	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	11	-0-	-0-	-0-
		134	-0-	1	19	5	-0-	2	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	32	**	-0-	-0-
		135	-0-	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-
	31	136	-0-	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	5	-0-	-0-	-0-	-0-	6	-0-	-0-	-0-
		137	-0-	1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	-0-
		138	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	5	-0-	-0-	-0-	-0-	6	-0-	-0-	-0-

Figure 4. Example of a Commonality Analysis Computer Printout Sheet.

Weighting factors of 0 percent were a special case. A zero weight meant that zero percent of the total number of crew positions of interest were comprised by the particular aircraft/ AFSC position under which the zero appeared. Zero weights typically occurred during the 1971-75 time period or during the 1986-90 time period. In the first time period, a zero weight indicated that the aircraft/AFSC position did not yet exist, and thus could only comprise zero percent of any total. The B-1 weapon system is a good example. No B-1 systems were projected for the 1971-75 time period; thus their crew positions during that time period would comprise zero percent of any total. Zero weights during the 1986-90 time period similarly indicated that associated aircraft/AFSC positions were not projected to exist. In this case, zero weights indicated that a particular weapon system and its crew position were projected to have been phased out of the inventory.

The second type of entry was a theta(-θ-). A theta entry indicated that the particular aircraft/AFSC position under which it appeared simply did not perform the particular subtask in the context of the commonality analysis which was being conducted. For example, commonality analysis printout section 1 dealt only with positions 1 and 2. Thetas were entered by the computer for each subtask under positions 3 through 14. This indicated that, in the context of the "within AFSC" commonality analysis presented in section 1, positions 3 through 14 do not perform any of the subtasks. Thetas appearing in commonality analyses across all 14 crew positions similarly indicated that certain aircraft/AFSC positions simply do not perform certain subtasks.

In reading the commonality analysis output, it could be noted that commonality weight entry numbers were always the same under each aircraft/AFSC position within any of the 20 different analyses. This was because the commonality weights represented percents of some total number of crew positions comprised by the positions associated with the particular aircraft/AFSC code. The percent composition factors, of course, were the same within each of the 20 analyses. Accordingly, the same weights appeared under each position within each sort.

Value sum column entries were totals of all commonality weights across all aircraft/AFSC positions of interest for each subtask. Numbers appearing in the value sum column represented the total percent of all crew positions of interest which performed each subtask. For example, a value sum of 25 meant that 25% of all aircraft/AFSC positions of interest for the particular commonality analysis performed the subtask. A value sum of 100 meant that 100% performed the subtask.

The commonality analysis printout also presented the results of commonality criterion checks. Three levels of commonality were arbitrarily selected. The levels were: 30%, 50% and 70%. Because of the lack of precedent and the subjectivity of task

analysis data, the three commonality criterion levels could not be based upon a firm technical foundation. However, it was desired to incorporate the commonality criteria check capability into the computer software for possible future utilization. Any three levels may be selected for use.

In the commonality criteria checks, the computer simply compared the value sum for each subtask against the three pre-selected commonality criteria. The presence of double asterisks (**) showed the criterion levels which the value sum equaled or exceeded. For example, commonality analysis section 10 (see Figure 4) presented results of an "all inclusive" commonality analysis across all 14 aircraft/AFSC positions for the 1976-1980 time period. Within this analysis, the criteria checks showed that at least 70% of all navigators will perform subtask number 121; at least 50% but less than 70% will perform subtask number 123; and at least 30% but less than 50% will perform subtask number 124. The exact percent values were shown in the value sum column. For example, 87% of all navigators will perform subtask number 121 during the 1976-1980 time period.

USING COMMONALITY ANALYSIS DATA

Commonality analysis data represent a relatively new type of information. Although the information is quantitative, it is based upon subjective task analysis data. There frequently is a tendency to view any new form of highly quantitative data as a means for solving more problems than history generally shows to have been practical. On the other hand, the availability of quantitative commonality data does hold the promise of providing insight into a number of problem areas which previously could be addressed only subjectively and argumentatively. Several such uses of commonality analysis data are presented below.

Commonality analysis data may provide a valuable basis for clustering job behaviors for the purpose of developing integrated and highly interrelated sets of training Criterion Objectives. This is the primary anticipated use of commonality analysis data for NOUFFSS Phase III.

It would also appear reasonable that commonality data may be useful in allocating various training requirements (Criterion Objectives) to particular training schools such as UNT, NBT, EWOT and even CCTs. Degrees of commonality could be used in conjunction with Criterion Objective content for this purpose.

It also appears reasonable to use degree of commonality to establish the degree to which selected behaviors should be trained. For example, training requirements based upon low commonality job behaviors might be trained in UNT, but only to a "familiarization level."

Commonality data also might provide one basis upon which total system structure and content might be based. For example, if all navigator training were to be conducted under Air Training Command auspices, commonality data might be useful in developing training program structure by establishing branching points from general skills through highly system specific skills.

Finally, commonality data might prove of value in restructuring flying specialty AFSCs into groupings more representative of future as well as present timeframe job requirements.

The use of commonality analysis data to achieve the clustering of related job behaviors is addressed in the next section.

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SECTION IV

COMMONALITY DATA SUMMARY

The commonality analysis performed on the task analysis data produced a voluminous number of individual subtask-level commonality measures. It was necessary, therefore, to summarize the data in order to search for trends.

1971-1985 TIMEFRAME

As shown in Tables 13 and 14, commonality weighting factors are quite stable throughout the 1971 to 1985 timeframe. Accordingly, results of the commonality analyses for the 1971-75, 1976-80 and 1981-85 timeframes are highly similar. The first step in summarizing the commonality analyses, therefore, was to combine the data from each of the three time periods into one data pool. For the comparisons which follow, only total commonality measures resulting from sorts across all 14 crew positions were used.

A useful method for treating voluminous data of the type generated by the commonality analysis is to code the individual measures into groups or class intervals. The class interval data may then be used to construct frequency distribution histograms and cumulative frequency distribution curves (Ref. 8). Accordingly, the 0% to 100% commonality scale was divided into ten class intervals. Each interval contained 10% of the total scale (i.e., 1% through 10%, 11% through 20%, etc.). Combined commonality weights for each subtask were coded by assigning them to the appropriate class interval. For example, a 7% commonality weight would be assigned to the 1% through 10% interval. The percent of the total number of weights which constituted each interval was then determined. The resulting relative frequency distribution is shown in histogram form in the bottom half of Figure 5.

The relative frequency data also are expressed as a cumulative frequency curve in the top half of Figure 5 . The cumulative curve was developed by successively combining the individual relative frequencies for each class interval and plotting the resulting cumulative values. The curve can be interpreted to show the total percent of subtasks falling at or below chosen commonality levels. For example, approximately 20% of the subtasks were 10% common or less; approximately 48% of the subtasks were 30% common or less.

Examination of the cumulative frequency curve for the 1971-1985 timeframe reveals that it is positively skewed, reflecting the fact that there was a relatively large percentage of unique, low commonality subtasks. The slope of the curve is most steep between the 1% and 20% commonality points. At the 20% commonality point, the slope becomes less pronounced, and a linear relationship is observed through the 50% commonality point. Above the 50% point, the slope becomes even less pronounced, and another linear relationship is observed through the 100% commonality point.

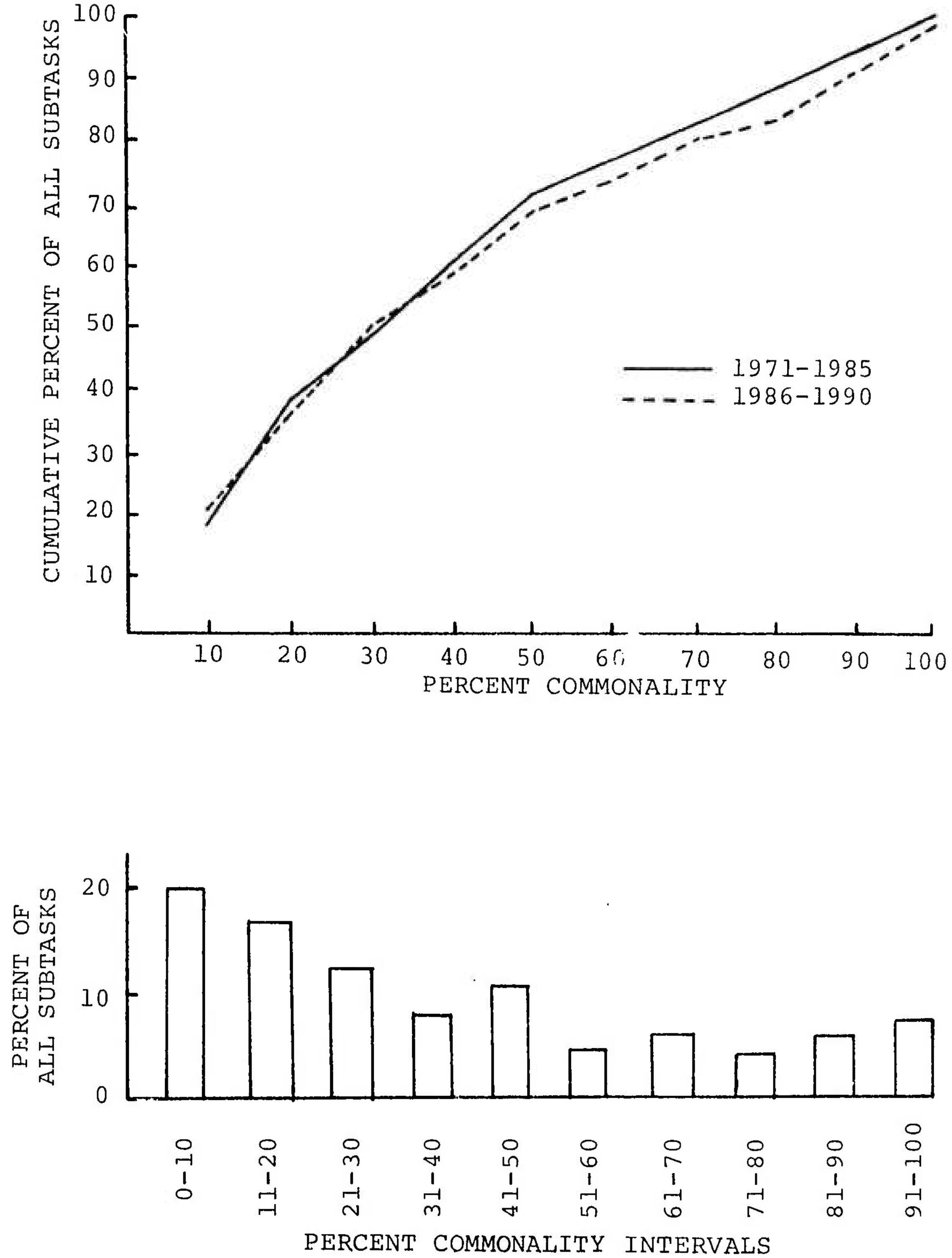

Figure 5. Commonality Trends.

Two points along the curve reflecting transitions in slope (20% and 50% commonality points) may be of potential value for application in NOUFFSS Phase III. The transition points identify notable changes in the commonality trend. Linearity of the three segments of the curve also indicates consistent trends within the three levels of commonality.

Consistency of trends within each level is further borne out by consistent trends in the histogram data. The two class intervals between 1% and 20% commonality average approximately 20% of the total number of commonality measures. The three intervals comprising the 30% through 50% range average approximately 12% of all measures. The intervals above 50% commonality average approximately 7% of all measures. Furthermore, variability among data within each of the three ranges is relatively small.

The above figures suggest that three levels of commonality may exist in the 1971 through 1985 commonality analyses: high commonality, but a low proportion of all subtasks; moderate commonality and a moderate proportion of all subtasks; and low commonality, but a high proportion of all subtasks. These trends, in turn, suggest that NOUFFSS Phase III should address the development of training requirements in a multilevel fashion.

1986 - 1990 TIMEFRAME

Figure 5 also presents cumulative commonality data for the 1986 - 1990 timeframe. The curve for the latter timeframe closely follows the combined 1971 - 1985 timeframe curve discussed above. The latter timeframe curve exhibits more variability, however. The variability may be due primarily to the smaller number of data available for generating the curve. Only one timeframe was used. An additional fact is that five of the 14 crew positions are not anticipated to exist during the 1986 - 1990 timeframe. Accordingly, the curve was developed from data for the remaining 9 positions only.

It is significant that general trends of the two curves are highly similar. Had the curves been markedly different, the multi-level commonality concept developed from 1971 - 1985 timeframe data might have been invalidated. As it is, basic application of the concept may have validity throughout the entire 1971 - 1990 timeframe.

ANTICIPATED PHASE III REQUIREMENTS

The presence of three distinct and consistent commonality levels suggests that more than simple statistical interpretation of task analysis data will be required during NOUFFSS Phase III. This follows from the fact that patterns in the commonality data do not appear to correlate with patterns in crew distribution data or weapon system distribution data.

Table 18 shows the percent of all navigators positions in the NOUFFSS sample which comprise each of the four flying specialties. Table 19 shows the percent of all navigator positions in the NOUFFSS sample broken out by aircraft type. Content of the tables was based upon NOUFFSS Phase I projections of the numbers of navigators required through 1990 (Ref. 2).

In developing content for both tables, the F-111 weapon system was assigned to the bomber category. Similarly, the F-111 WSO was categorized as a Radar Navigator. This was done for two reasons. First, the F-111 performs a bomber mission, not a fighter mission. Second, tasks performed by the F-111 navigator far more closely correspond with tasks performed by Radar Navigators in the FB-111, B-1 and even the B-52 than they do with F-4 Weapon System Officer tasks. This results primarily from the fact that the F-111 does not fill an air intercept role.

Regardless of how one treats the F-111, patterns apparent in the tables are not meaningfully changed in relationship to patterns in Figure 5. Examination of the tables shows that relative distribution patterns apparent in the tabled data do not correspond with commonality patterns shown in Figure 5. This suggests that commonality measures and trends are the product of interactions among variables such as mission types, weapon system and equipment types, AFSCs, and probably task relatedness factors reflecting uniquenesses between weapon systems within each of the general categories. The full implications of such factors remain to be explored in NOUFFSS Phase III. It appears, however, that more than simple statistical interpretation of task analysis and commonality analysis data will be required.

COMMONALITY CRITERIA AND CONSTRAINTS

It must be noted that even under the most rigorous scientific and technical controls, the establishment of criteria involves an element of arbitrary decision. Criterion values are not inviolable. They are influenced by the amount of information available when the decision is made, the consideration of factors other than statistical summaries, and the technical backgrounds and viewpoints of those who make the decision. In answering the question "What is common?", one must first ask "Common to whom, for what particular application, and under what circumstances?"

Prior attempts to establish commonality criteria disregarded many questions with what appears to have been the arbitrary selection of a 40% commonality cutoff point (Ref. 6). Task data of less than 40% commonality were simply ignored. In the present study, all data are judged to be meaningful and, therefore, should not be ignored. Statistical support for a multi-level commonality concept provides a framework within which all task data may be considered for the development of training Criterion Objectives during Phase III.

Table 18. Percent of Navigators in NOUFFSS Sample Comprising Each AFSC.

	Air Force Specialty Codes			
	1525 (RN)	1535 (NAV)	1555 (WSO)	1575 (EWO)
1971-1985 Averages	14%	62%	18%	6%
1986-1990 Averages	29%	61%	--	10%

Table 19. Percent of Navigators in NOUFFSS Sample According to Aircraft Type.

	Aircraft Types				
	Transport	Bomber	Fighter	Refueler	Other*
1971-1985 Averages	36%	25%	18%	15%	6%
1986-1990 Averages	41%	39%	--	17%	3%

* Reconnaissance and Perimeter Patrol.

NOTE - The reader may change the content of the tables to reflect presently existing mission and job categories of the F-111. For the 1971-1985 timeframe, subtract 6% from the RN category of Table 15, and add 6% to the WSO category. Similarly, subtract 6% from the bomber category of Table 16, and add 6% to the fighter category. For the 1986-1990 timeframe, perform the same steps, but use 18% instead of 6%.

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SECTION V

FUNCTION, TASK AND SUBTASK DESCRIPTIONS

EXPLANATION

This section presents in catalog form all the functions, tasks and subtasks developed for all the aircraft in the NOUFFSS Phase II effort. The functions are listed together with their associated tasks and subtasks in a "shopping list" manner and consequently, do not necessarily represent any particular weapon system task requirement or operational sequence. Micro-functions are not presented because of their uniqueness to individual weapon systems or crew positions in the Phase II NOUFFSS sample.

Functions are shown in all capital letters and are numbered consecutively from 01 through 29. Tasks are shown as the first level of indenture and are numbered consecutively from 001 through 107. Subtasks are listed at the second level of indenture and are numbered consecutively from 001 through 446.

Titles for the following numbered subtasks are classified: 088, 127, 130, 166 and 167. Each of the subtasks applied only to the B-1 weapon system. The titles are contained in Section IX (Ref 9) of Phase II documentation which is included in Appendix I (Phase I)(Secret), in order to keep all classified material in one document. Section IX also presents classified names of subsystems anticipated for the B-1. Code equivalents of the names were used in Microfunction data developed for the B-1.

01 EXECUTE MISSION PLANNING PROCEDURES

001 Receive Mission Information

- 001 Receive Mission Order
- 002 Receive Mission Briefing
- 003 Receive Target Study Briefing
- 004 Receive Intelligence Briefing
- 005 Receive Lead Navigator Enroute Briefing
- 006 Receive Lead Navigator Drop Zone Briefing
- 007 Receive Specialized Briefing

002 Analyze Flight Operations Order

- 008 Analyze Navigation Portion of Operation Plan
- 009 Conduct Briefing on Navigation Portion of Plan
- 010 Verify Aircraft Performance Safety Margins
- 011 Evaluate Effect of Ordinance on Mission Profile
- 012 Analyze EW Portion of Mission
- 013 Conduct Briefing on EW Portion of Operation Order

003 Analyze Documents on Terrain, Weather and Other Factors

- 014 Check Documents for Flight Limiting Factors
- 015 Obtain Enroute Wind and Weather Data
- 016 Obtain Emergency Information for Mission

004 Prepare Flight Plan and Navigation Maps

- 017 Receive Planned Route Information
- 018 Prepare Mission Flight Plan
- 019 Determine Fuel Consumption Data
- 020 Verify Flight Plan Complies with Appropriate Regulations
- 021 Assist Crewmembers in Preparing Mission Data
- 022 Prepare Enroute Maps with Appropriate Data
- 023 Review Prepared Map Data

005 Perform Tactical Operations Planning

- 024 Check Communications and Security Documents
- 025 Prepare Low Altitude Tactical Segment of Mission
- 026 Prepare Weapon Delivery Segment of Mission
- 027 Prepare Reconnaissance Segment of Mission
- 028 Prepare Air Drop Segment of Mission
- 029 Prepare Electronic Warfare Segment of Mission
- 030 Perform Specialized Target Study for Terminal Guided Weapons

01 (Function Continued)

006 Check Adequacy and Currency of Mission Documents

031 Check Adequacy and Currency of Navigation Documents
032 Check Adequacy and Currency of Weapon Delivery Documents
033 Check Adequacy and Currency of Emergency Documents
034 Check Reconnaissance Equipment Data

007 Prepare Programming and Launching Data for Missiles

035 Evaluate Missile Complement
036 Program Launch of SRAM AGM-69 Missiles
037 Program Launch of Houndog AGM-28 Missiles
038 Program Launch of Quail ADM-20 and Agile Missiles
039 Program Launch of Scad and Scud Missiles

02 SECURE FLIGHT AND LIFE SUPPORT EQUIPMENT

008 Don Life Support and Survival Equipment

040 Don Flight Clothing
041 Check Headgear Equipment
042 Check Survival Equipment
043 Inspect Personal Weapon

03 VERIFY AIRCRAFT EXTERIOR CONDITION

009 Inspect External Antennae or Antennae Covers

044 Inspect Condition of Antennae
045 Inspect Condition of Antennae Covers

010 Inspect Weapons Equipment

046 Perform Preinspection Safety Checks
047 Check Bomb Load
048 Check Nuclear Weapons Safeing and Release System
049 Inspect Bomb Release System

03 (Function Continued)

011 Inspect Missiles

- 050 Inspect SRAM AGM-69 Missiles
- 051 Inspect Houndog AGM-28 Missiles
- 052 Inspect Sparrow AIM-7 Missiles
- 053 Inspect Falcon AIM-4 Missiles
- 054 Inspect Maverick AGM-65 Missiles
- 055 Inspect Sidewinder AIM-9 Missiles
- 056 Inspect Quail ADM-20 Missiles
- 057 Inspect Bullpup AGM-12 Missiles
- 058 Inspect Shrike AGM-45 Missiles
- 059 Inspect Scad Missiles

012 Check External Equipment Stores

- 060 Check External Reconnaissance Equipment Stores
- 061 Check External EW Equipment and Stores
- 062 Check External Reconnaissance Equipment

013 Inspect External Aircraft General Conditions

- 063 Inspect General Aircraft Exterior

04 VERIFY AIRCRAFT INTERIOR CONDITION

014 Inspect Aircraft Canopy

- 064 Check Canopy Serviceability

015 Inspect Escape Survival Equipment

- 065 Check Ejection Seat or Capsule
- 066 Inspect Parachutes
- 067 Check Onboard Oxygen Equipment
- 068 Check Survival Equipment

016 Inspect Weapons Control and Weapons Monitoring Equipment

- 069 Verify Weapons are Safe and Inactive
- 070 Perform Nuclear Weapons Safety Check Procedures

017 Inspect Documents Records and Publications

- 071 Check Navigation Documents
- 072 Check Maintenance Documents
- 073 Check Weapon Delivery Tables
- 074 Check Crypto Materials and Special Mission Instructions

018 Check Circuit Breaker Panels

- 075 Check Circuit Breaker Panels Properly Set

05 EXECUTE POWER OFF EQUIPMENT CHECKOUT

019 Perform Power Off Checks of Navigation Equipment

076 Check Radar Equipment
077 Check Doppler Equipment
078 Check Inertial Equipment
079 Check Loran Equipment
080 Check Sextant
081 Check ADF Radio
082 Check Radio or Radar Altimeter
083 Check Navigation Computer
084 Check Compass Equipment

020 Perform Power Off Checks of Other Navigation Equipment

085 Check Astrotracker
086 Check Omega Equipment
087 Check Satellite Navigation System
088 Check System Eleven

021 Perform Power Off Checks of Communication Equipment

089 Perform Radio Equipment Checks
090 Perform Rendezvous Equipment Checks

022 Perform Power Off Checks of EW Equipment

091 Check EW Transmitter Equipment
092 Check EW Receiver Equipment
093 Check EW Signal Analysis Equipment
094 Check Expendable Stores Equipment
095 Check Other EW Equipment

023 Perform Power Off Checks of Other Required Subsystems

096 Check Side Looking Radar Equipment
097 Check Avionics Environmental Control Equipment
098 Check LLLTV Equipment
099 Check Photographic Equipment
100 Check Electrical Test Receptacle
101 Check Throttle Interconnect
102 Check Infrared Detection Equipment
103 Check Forward Looking Radar Equipment
104 Read Checklists for Pilot

06 EXECUTE POWER ON EQUIPMENT CHECKS

- 024 Monitor Engine Start
  - 105 Monitor Engine Start
  - 106 Assist Pilot with Fuel Checks
- 025 Activate Required Electrical Circuits
  - 107 Check Voltage and Frequency Levels
- 026 Perform Operational Checks of Navigation Radios
  - 108 Perform Loran Equipment Operational Checks
  - 109 Perform Navigation Radios Operational Checks
  - 110 Perform Tacan Equipment Operational Checks
  - 111 Perform Omega Operational Checks
- 027 Perform Operational Checks of Navigation Computers
  - 112 Verify Mission Tape Data Stored in GNC and WDC Computers
  - 113 Perform Navigation Computer Operational Checks
  - 114 Perform Operational Check of EMAC Equipment
  - 115 Perform BNS Operational Checks
  - 116 Enter Present Position Data into Computer
  - 117 Enter Enroute Navigation Data into Computer
  - 118 Enter Vertical Navigation Data into Computer
  - 119 Enter Data Into Energy Management Computer
  - 120 Enter Drop Zone Information into AWADS Computer
- 028 Perform Operational Checks of Other Navigation Equipment
  - 121 Perform Search Radar Operational Checks
  - 122 Perform Terrain Following Radar Operational Checks
  - 123 Perform Doppler Equipment Operational Checks
  - 124 Perform Inertial Equipment Operational Checks
  - 125 Perform Compass System Checks
  - 126 Perform Astrotracker Operational Checks
  - 127 Perform System Eleven Checks
- 029 Perform Communication Equipment Checks
  - 128 Perform Radio Operational Checks
  - 129 Perform Identification Equipment Operational Checks
  - 130 Perform System Fourteen Checks
  - 131 Participate in Authenticator Check
  - 132 Request Copy and Authenticate Training Launch Message
- 030 Perform EW Equipment Operational Checks
  - 133 Perform Transmitter Equipment Checks
  - 134 Perform Receiver Equipment Checks
  - 135 Perform Signal Analysis Equipment Checks

06 (Function Continued)

031 Perform Reconnaissance Equipment Power On Checks

- 136 Perform Side Looking Radar Checks
- 137 Perform LLLTV Checks
- 138 Perform Photo Equipment Checks
- 139 Perform Infrared System Checks
- 140 Perform Photo Flash Cartridge Checks
- 141 Check Other Sensor Systems

032 Perform Operational Checks of Bombing Equipment

- 142 Perform Bombing Equipment Calibration and Functional Checks

033 Perform Fire Control Operational Checks

- 143 Perform Fire Control Equipment Calibration
- 144 Deactivate Fire Control Equipment

034 Perform Operational Checks of Missile Equipment

- 145 Perform Missile Equipment Calibration Checks
- 146 Perform Missile Equipment Functional Checks

035 Perform General Aircraft Subsystem Checks

- 147 Set Flight Instruments
- 148 Check Flap and Gear Indicators
- 149 Adjust Cockpit Lighting
- 150 Check Warning and Caution Indicator Lights
- 151 Check General Aircraft Subsystems
- 152 Check Autopilot Release Procedure
- 153 Monitor Flight Control Functional Checks
- 154 Monitor Electrical Changeover
- 155 Monitor Propulsion Subsystem Functional Checks

036 Prepare Life Support Subsystems

- 156 Secure Restraint System
- 157 Activate Oxygen Subsystem
- 158 Perform G-Suit Check
- 159 Arm Ejection Seat
- 160 Arm Ejection Capsule
- 161 Stow Miscellaneous Equipment

07 EXECUTE TAXI PROCEDURES

037 Monitor Required Communication Links

162 Monitor Interphone
163 Monitor External Communications
164 Communicate with Ground Control
165 Check HF Radio
166 Monitor System Eleven
167 Monitor System Fourteen

038 Assist in Taxi Operations

168 Read Required Checklists
169 Configure Subsystem as Required During Taxi
170 Assist Pilot in Taxi Operations
171 Assist Other Crewmembers in Taxi Operations

08 EXECUTE TAXI AND PRETAKEOFF SUBSYSTEM CHECKS

039 Check Status of Subsystems Prior to Takeoff

172 Read Required Checklists
173 Check Navigation Equipment
174 Check Communication Equipment
175 Check Readiness of EW Equipment
176 Check Bomb-Navigation Equipment
177 Check External Stores and Other Sensors
178 Check All Warning and Malfunction Indicators
179 Perform General Aircraft Checks
180 Check Status of Nuclear Weapons Monitoring Equipment

040 Initiate Navigation System Sequencing

181 Initiate Navigation System Sequencing

09 EXECUTE TAKEOFF CLIMB AND DEPARTURE PROCEDURES

041 Monitor Aircraft Takeoff Performance

182 Check Aircraft Acceleration Rate
183 Monitor Aircraft Rate of Climb
184 Monitor Wingman Configuration and Position

042 Monitor Adherence to Departure Clearance

185 Monitor Adherence to Required Departure Procedure

09 (Function Continued)

043 Assist Pilot in Takeoff and Climb

186 Read Required Checklist
187 Configure Flight Subsystems as Required

044 Configure Required Subsystems for Climb

188 Activate EW Equipment
189 Configure Navigation Subsystems for Climb
190 Configure Communications Equipment for Climb
191 Configure Reconnaissance Subsystems for Climb
192 Perform Authenticator Check
193 Setup AGM-28 Missile
194 Configure EMAC for Climb and Cruise

045 Perform Airborne Calibration Checks

195 Calibrate EW Receivers
196 Calibrate Radar Warning System
197 Calibrate EW Transmitters
198 Calibrate Receiver-Transmitter
199 Check Programmers
200 Check Rocket Launchers
201 Perform Defensive Exercise
202 Check Other EW Systems

10 DIRECT AIRCRAFT ALONG REQUIRED ROUTE

046 Configure Subsystems for Cruise

203 Read Required Checklists
204 Configure Radar for Enroute Operation
205 Setup Life Support System for Cruise
206 Perform TAS Calibration Check
207 Determine Best Heading Input
208 Setup Navigation Radios
209 Setup Navigation Computer as Required
210 Setup EW Equipment for Cruise
211 Perform Weapons Systems Monitoring Checks
212 Perform Bombing System Checks

047 Monitor Flight Performance

213 Monitor Flight Control and Propulsion
214 Monitor Communications
215 Assist Pilot with Controlability Checks
216 Perform Visual Search
217 Update Antenna Tilt Setting

10 (Function Continued)

048 Identify Landmark

218 Determine Landmark Update Point Identification
219 Identify Landmark Location Visually
220 Identify Landmark Location Using Radar
221 Identify Landmark Using Other Sensors

049 Determine Aircraft Position

222 Utilize Pilotage Data
223 Utilize Tacan to Determine Position
224 Utilize Manual Celestial Data
225 Utilize Automatic Celestial Procedure
226 Utilize Loran Data
227 Utilize Omega Data
228 Integrate Position Information from Multiple Sources
229 Update Navigation Computer as Required
230 Monitor Automatic Navigation System

050 Compute Changes Required to Maintain Track Altitude and Airspeed

231 Compute New Heading Manually
232 Compute New Heading Automatically
233 Compute Required Altitude Changes
234 Perform Timing Point Computations

051 Compute Allowances for Enroute Weather and Wind

235 Monitor Weather Situation
236 Determine Wind Velocity and Direction Manually
237 Read Wind Data Displays
238 Utilize Radar Timing Techniques to Determine Winds
239 Determine Wind Using Fix to Fix
240 Utilize Memory Point Wind Run
241 Project Future Wind Conditions Along Route
242 Direct Aircraft Along Penetration Route
243 Coordinate with Controlling Agency

052 Compute Track and Groundspeed

244 Utilize Chart Plotter and Manual Computer
245 Obtain Groundspeed Using Radar Target Timing Techniques
246 Read Data on Appropriate Display

10 (Function Continued)

053 Prepare Inflight Position Report

247 Prepare Position Report
248 Transmit Position Report
249 Monitor Data Link Position Reporting

054 Perform Inflight Fuel Management Procedures

250 Plot Actual Fuel Data on Appropriate Forms
251 Use Energy Management Computer to Determine Fuel Data
252 Alter Vertical Navigation Based on Calculations
253 Determine if Fuel is Adequate for Mission Completion

11 EXECUTE LOW LEVEL OPERATIONS

055 Configure Aircraft for Descent and Low Level Attack

254 Perform TFR Operational Check
255 Perform Terrain Avoidance Radar Checks
256 Update Low Level Bombing Data
257 Jettison Fuel Tanks
258 Perform Predescent and Descent Checks
259 Deactivate Nonessential Equipment

056 Monitor Flight Performance

260 Monitor Flight Control and Propulsion
261 Monitor Communications
262 Assist Pilot with Controlability Checks
263 Perform Visual Search
264 Monitor Terrain Following System

12 EXECUTE PENETRATION DEFENSIVE PROCEDURES

057 Perform Penetration Procedures

265 Preset EW Equipment for Briefed Electronic Environment
266 Monitor Threat and Countermeasure Indications
267 Perform Appropriate Countermeasure
268 Perform Flight Radar Jamming

13 DIRECT AIRCRAFT TO CARP

058 Configure Required Subsystems for Low Level Cargo Drop

269 Read Required Checklists
270 Setup Life Support System for Low Level
271 Configure Radar for Low Level
272 Set Flight Instruments
273 Coordinate with Pilot as Required

059 Compute CARP

274 Determine CARP Using AWADS System
275 Determine CARP Manually
276 Determine CARP Using IDNE Equipment

060 Direct Aircraft to CARP

277 Identify Timing Landmark Visually
278 Identify Timing Landmark Using Radar
279 Direct CARP Approach
280 Advise Cargo to be Released
281 Perform Post Drop Procedures
282 Compute Joinup Data

14 EXECUTE RECONNAISSANCE PROCEDURES

061 Configure Aircraft for Reconnaissance Run

283 Read Required Checklists
284 Configure Equipment for Mission

062 Perform Reconnaissance Mission

285 Identify Initial Point
286 Activate Reconnaissance Sensors
287 Maintain Required Track

063 Perform Escape Procedures

288 Deactivate Nonessential Sensors
289 Monitor Escape Procedures
290 Perform Reconnaissance Reports
291 Determine if Fuel is Adequate for Mission Completion

15 EXECUTE SECTOR PATROL NAVIGATION

064 Perform Navigation System Setup

292 Setup Computer for Sector Patrol
293 Check Subsystem Operation

065 Determine Aircraft Position

294 Utilize Pilotage Data
295 Request Ground Radar Fix
296 Utilize Omega to Determine Position
297 Utilize Loran Data
298 Monitor Automatic Navigation System
299 Integrate Position Information from Multiple Sources

066 Update Navigation System

300 Update Navigation Computer as Required
301 Determine Landmark Update Point Identification
302 Identify Landmark Location Using Radar

067 Compute Changes Required to Maintain Track and Airspeed

303 Compute New Heading Automatically
304 Perform Timing Point Computations

068 Prepare Inflight Position Report

305 Prepare Position Report
306 Transmit Position Report
307 Monitor Communications

16 EXECUTE RENDEZVOUS OPERATIONS

069 Configure Aircraft Subsystems for Rendezvous Operations

308 Configure Radar Beacon for Rendezvous
309 Activate Rendezvous Beacon
310 Configure IFF-SIF for Rendezvous
311 Configure Inertial Equipment for Rendezvous
312 Deactivate Nonessential Equipment

070 Identify Rendezvous Aircraft

313 Perform Rendezvous Communications
314 Estimate Receiver Aircraft Position
315 Compute Position of Tanker Relative to Receiver
316 Identify Tanker or Receiver Aircraft

17 EXECUTE REFUELING JOINUP

071 Compute Refueling Position for Receiver or Tanker

317 Compute Offset Range and Bearing
318 Direct Tanker Aircraft to Required Turning Point

072 Perform Refueling Safety Procedures

319 Perform Prerefueling Procedures
320 Monitor Refueling Operation
321 Activate Required Subsystems After Fueling
322 Perform Post Refueling Operations

18 EXECUTE WEAPON RELEASE PROCEDURES

073 Perform Strike Verification Procedure

323 Authenticate Strike Order

074 Configure Required Subsystems for Low Level Weapon Delivery

324 Read Required Checklists
325 Configure Radar for Weapon Delivery
326 Set Flight Instruments
327 Configure Weapon Computer for Weapon Delivery
328 Configure LABS for Weapon Delivery
329 Coordinate General Aircraft Subsystems for Low Level Delivery

075 Perform Nuclear Weapons Prerelease Procedures

330 Activate Nuclear Weapon Lock and Release Equipment
331 Perform Prearming of Nuclear Weapons

076 Perform High Explosive Weapons Prerelease Procedure

332 Prepare Weapons for Release

077 Direct Aircraft to Weapons Release Point

333 Direct Aircraft to Horizontal Release Point
334 Direct Aircraft to Dive Bombing Release Point
335 Analyze Target Damage for Restrike Requirement
336 Perform Weapons Release Procedures
337 Monitor Post Release Recovery
338 Configure Equipment for High Altitude Mission

19 EXECUTE MISSILE LAUNCH PROCEDURES

078 Program Missiles for Targets

339 Verify Target Coordinates
340 Verify Missile Flight Profile and Flight Path
341 Verify Fuzing Data
342 Program SRAM AGM-69 Missiles
343 Monitor Missile Launch

079 Prepare Missiles and or Sensor for Launch

344 Configure Radar in Search Mode
345 Identify Launch Landmark
346 Update Missile Guidance Relative to Landmark
347 Perform Launch Procedures
348 Configure Fire Control System for Missile Launch

20 EXECUTE POST RELEASE PROCEDURES

080 Perform Post Release Procedures

349 Perform Nuclear Weapons Safeing Procedures
350 Perform Conventional Weapon Safeing Procedure
351 Perform Missile Post Launch Procedures

081 Perform Initial Bomb Damage Assessment Procedures

352 Evaluate Target Damage
353 Prepare Strike Report

21 EXECUTE AIR-TO-AIR SEARCH AND SURVEILLANCE PROCEDURE

082 Configure Sensor Subsystems for Search Operation

354 Configure Fire Control Radar
355 Configure Other Sensor Equipment
356 Perform Visual Search

083 Perform Air-to-Air Search and detection Operations

357 Perform Surveillance of Required Area
358 Detect Unknown Target

084 Perform Target Identification Procedures

359 Utilize Visual Recognition
360 Utilize Available Sensors
361 Verify Unknown is Enemy

22 EXECUTE INTERCEPT OPERATIONS

085 Perform Intercept Procedures

362 Determine Probable Track of Target
363 Determine Intercept Route
364 Direct Aircraft to Intercept Track

086 Configure Weapons Subsystem for Ordinance Delivery

365 Prepare Missiles for Launch
366 Prepare Guns
367 Verify Mode and Status of Weapon Control Equipment
368 Perform Post Missile Launch Procedures

23 EXECUTE CONTINGENCY OPERATIONS

087 Perform Inflight Mission Replanning

369 Replan to avoid Adverse Weather
370 Receive Change in Mission Objective
371 Plan Route to Alternate Target Using Automatic Method
372 Plan Route to Alternate Target Using Manual Method

088 Perform Equipment Malfunction Analysis

373 Isolate Malfunction
374 Replace Malfunctioning Unit
375 Configure Subsystem for Alternate Modes of Operation
376 Utilize Appropriate Manual Procedures

24 EXECUTE EMERGENCY PROCEDURES

089 Perform Emergency Inflight Replanning

377 Determine Aircraft Position
378 Determine Position of Nearest Usable Emergency Field
379 Compute New Fuel Requirements

24 (Function Continued)

090 Perform Appropriate Action for Equipment Fires

380 Identify Source of Fire
381 Deactivate Required Subsystem
382 Request Assistance
383 Perform Fire Fighting Functions
384 Advise Aircraft Commander of Subsystem Status
385 Transmit Emergency Message
386 Assist Pilot with Aircraft Emergencies

091 Perform Aircraft Airborne Evacuation Procedures

387 Perform Preevacuation Procedures
388 Perform Bailout Procedures
389 Perform Ejection Procedures

092 Prepare for Ditch or Crash Landing

390 Prepare Emergency and Survival Equipment
391 Assume Ditching or Crash Landing Position
392 Evacuate Ditched Aircraft
393 Secure Loose Gear
394 Prepare Emergency Message
395 Prepare Escape Mechanism for Ditching
396 Evacuate Crashed Aircraft

25 EXECUTE DESCENT AND APPROACH PROCEDURES

093 Configure Navigation Subsystems for Approach and Landing

397 Setup Navigation Radios
398 Insert Vertical Navigation Data into Computer
399 Insert Horizontal Navigation Data into Computer
400 Update Computer with Present Position Data Using Radar
401 Secure Sextant

094 Configure EW Equipment for Descent and Approach

402 Perform Prelanding EW Equipment Checks

095 Monitor Approach and Letdown Procedures

403 Monitor Navigation Subsystems
404 Monitor ATC Communications
405 Monitor Aircraft Performance
406 Perform Routine Safety Procedures

25 (Function Continued)

096 Perform Onboard Landing Approach

407 Configure Radar for Airborne Directed Approach
408 Direct Aircraft Along Approach
409 Update Computer with Present Position Data Using Radar
410 Configure IDNE Computer for ADA

26 EXECUTE POST MISSION TAXI PROCEDURES

097 Assist Pilot in Taxi Operations

411 Read Appropriate Checklist
412 Monitor Ground Control Communications
413 Assist Pilot in Taxi Operations
414 Assist in Post Flight External Weapon Safety Inspection
415 Open Canopy
416 Complete Reconnaissance Forms

098 Perform Hot Refueling Procedures

417 Read Required Checklist
418 Monitor Interphone and UHF Communications
419 Monitor Refueling Supervisor
420 Record Quantity of Fuel Serviced

27 EXECUTE POST OPERATION CHECK AND SHUTDOWN PROCEDURES

099 Perform Ejection Equipment Safety Check

421 Safety Ejection Seat
422 Safety Canopy
423 Safety Ejection Capsule

100 Perform Post Flight Electrical Checks

424 Perform Voltage and Frequency Checks

27 (Function Continued)

101 Perform Subsystem Equipment Shutdown Procedures

425 Deactivate Navigation Equipment
426 Deactivate Communication Subsystems
427 Deactivate EW Equipment
428 Deactivate Reconnaissance Equipment
429 Deactivate Bomb-Navigation System
430 Deactivate Fire Control Subsystem
431 Disconnect Helmet and Oxygen Equipment
432 Deactivate Other Subsystems
433 Coordinate Engine Shutdown with Pilot
434 Exit Aircraft

28 EXECUTE AIRCRAFT POST FLIGHT EXTERIOR INSPECTION

102 Inspect External Antennae or Antenna Covers

435 Inspect Condition of Antennae
436 Inspect Condition of Antenna Covers

103 Inspect External Weapons and Missile Equipment

437 Inspect Bomb Release System

104 Check External Equipment Stores

438 Check External Reconnaissance Equipment Stores
439 Check External EW Equipment and Stores

105 Inspect External Aircraft General Condition

440 Inspect General Aircraft Exterior

29 EXECUTE MISSION DEBRIEFING

106 Record Data in Logs Records Forms and Booklets

441 Complete Maintenance Forms
442 Complete Intelligence Debriefing
443 Complete Flight Weather Debriefing
444 Complete Other Forms
445 Assist Photo Interpreters in Film Analysis

107 Secure Personal Equipment

446 Secure Equipment

SECTION VI "PRECEDING PAGE BLANK-NOT FILMED."

COMMONALITY SORT COMPUTER PROGRAM DESCRIPTION

DISCUSSION

The COMMONALITY SORT computer program was designed to identify the commonality of subtask-level data. Fundamentally, the program was designed to provide an output in which functions were ordered sequentially, tasks were ordered sequentially within functions, and subtasks were ordered sequentially within tasks. In this manner, the output of the commonality program would correspond with the task catalog contained in Section V. A high level block diagram of the COMMONALITY SORT program logic flow is shown in Figure 6. Detailed flows are presented at the end of this section.

For each subtask, the program identified whether each of the 14 crew positions performed the task, selected the appropriate subtask weighting factor for each crew position, and totaled the weights across all relevant crew positions. The totaled weighting factor was then compared against three pre-selected criteria, and results of the comparison established.

All data were input and output in numeric form. The output presented function numbers, task numbers, subtask numbers, appropriate weighting factors for each of the 14 crew positions, total weighting, and results of tests against the three pre-selected criteria.

Data entry card format is described below:

Columns	Content
1 and 2	Two digit crew position code (01 through 14)
4 and 5	Two digit function number
7, 8, & 9	Three digit task number
11 - 13	Three digit subtask number
15 - 17	Three digit subtask number
19 - 21	Etcetera subtask numbers, to a maximum of ten subtasks

The COMMONALITY SORT program sorts a maximum of 1300 individual cards of data, each one containing no more than 13 specific fields, on the predetermined parameters for a predetermined number of repetitions. This task is handled by spliting the job into nine separate subprograms, each one of which is briefly described in the paragraphs to follow.

I. DRIVER PROGRAM DRIVER is the main segment of the task. PROGRAM DRIVER first reads all data cards into core. This done, SUBROUTINE DPRINT prints this data, while SUBROUTINES SORT and SORT1 sort it on a predetermined key. PROGRAM DRIVER then begins to read the first set of two sort control cards, calls SUBROUTINE DOTASK to perform the commonality sort and eventually determines when the entire task has been completed.

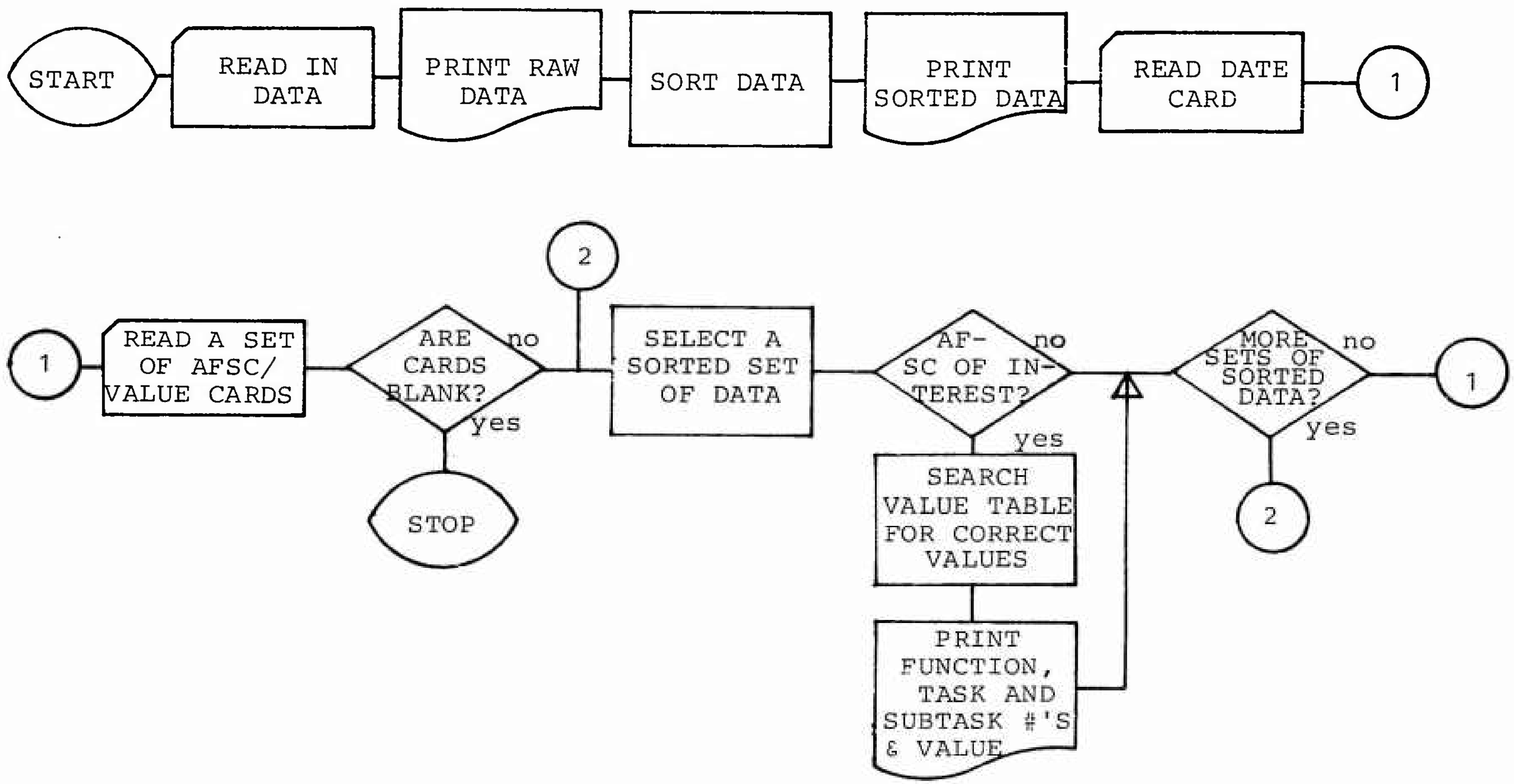


Figure 6. High Level Block Diagram of COMMONALITY SORT Program Logic Flow.

II. DPRINT SUBROUTINE DPRINT, when called by PROGRAM DRIVER, simply dumps that portion of core storage containing the job's data.

III. SORT SUBROUTINE SORT is called by PROGRAM DRIVER to sort the data array on a predetermined key value. When called by SUBROUTINE SORT1, SUBROUTINE SORT sorts only a specific portion of this data array, again on a predetermined sorting key.

IV. SORT1 SUBROUTINE SORT1 is able to calculate the beginning and ending points in the data array of a set of identical fields. SUBROUTINE SORT is then called to sort the data array within these calculated points.

V. DOTASK SUBROUTINE DOTASK is the longest and most involved of the subprograms in the COMMONALITY SORT program. Very basically, SUBROUTINE DOTASK selects a specific segment of the data array based upon which AFSC/Crew Member number is significant to the particular section being processed. SUBROUTINE DOTASK, in performing this sorting and selecting process, calls upon the remaining subprograms in the task: SUBROUTINES CKAFSC, DOL, PRINT, and HEADING. For this reason, DOTASK consumes both the most code and the greatest amount of CPU time.

VI. CKAFSC SUBROUTINE CKAFSC determines whether or not a particular data array segment contains a significant AFSC/Crew Member number.

VII. DOL SUBROUTINE DOL looks at a selected data array segment supplied to it by SUBROUTINE DOTASK and flags a special word. This word is later used by SUBROUTINE PRINT to find the correct value for that data array segment.

VIII. HEADING SUBROUTINE HEADING keeps track of the number of lines printed per page. When necessary, SUBROUTINE HEADING generates and prints either a new section or page heading for a new page of output.

Computer processing in the COMMONALITY SORT program proceeds in the following way:

1. Source language (in this case, FORTRAN) cards are read and translated by the source compiler (again, in this case FORTRAN) into machine language or "object" code. This code is stored, along with the source language listing, on magnetic tape.

2. At program execution time, the object code is read into the computer's central processing unit (CPU or "main frame") and control is turned over to it.

3. The program first commands that all data cards, up to a maximum of 1300, be read into core memory.

4. All raw data read into memory via the preceding step are then printed, exactly as read, onto the printed page, fifty lines per sheet. This raw data table may later be checked to verify that all data cards have been read without alteration.

5. Raw data stored in core are then sorted in two steps. The first step sorts data in ascending order on function number; the second step sorts equal function numbers on ascending task numbers.

6. Sorted data are printed, as before, fifty lines to a page. This catalog of sorted information provides a redundant checking of future output against initial values.

7. Now, the first set of AFSC/VALUE cards is read. These sets of cards are "cues" to the program telling it which AFSC combinations to search for and what weighting factors to use in value computations.

8. Each individual sorted data element is tested against the AFSC numbers read in the previous step. If a match is found, a sort is made on subtask numbers within equal task and function numbers that all have AFSC's of interest.

9. Once the sort described in the previous step is completed for a particular AFSC of interest, a printout is initiated in a prescribed tabular format.

10. Steps 9 and 10 are repeated until all data elements have been tested, at which time a new AFSC/VALUE card set is read and the process just described is again carried out.

11. When the last AFSC/VALUE card set has been read and its associated commonality sort has been completed, program execution terminates and processing comes to a halt.

The COMMONALITY SORT program is written in Control Data Corporation (CDC) modified American National Standards Institute (ANSI) FORTRAN. It was compiled, tested and production run on CDC 3000 Series hardware under control of CDC's MASTER operating system.

The program deck is composed of two major sections, as is common with most all FORTRAN programs. The first section (Figure 7) contains the punched card FORTRAN source language program, while the second section (Figure 8) contains both the raw data cards and the AFSC/VALUE card sets.

Modern automated data processing is conducted under the direction of a special computer program called the operating system (OS). The OS program acts as a master overseer that partitions CPU time and assigns computer control to the various individual programs waiting to be processed. Special instructions

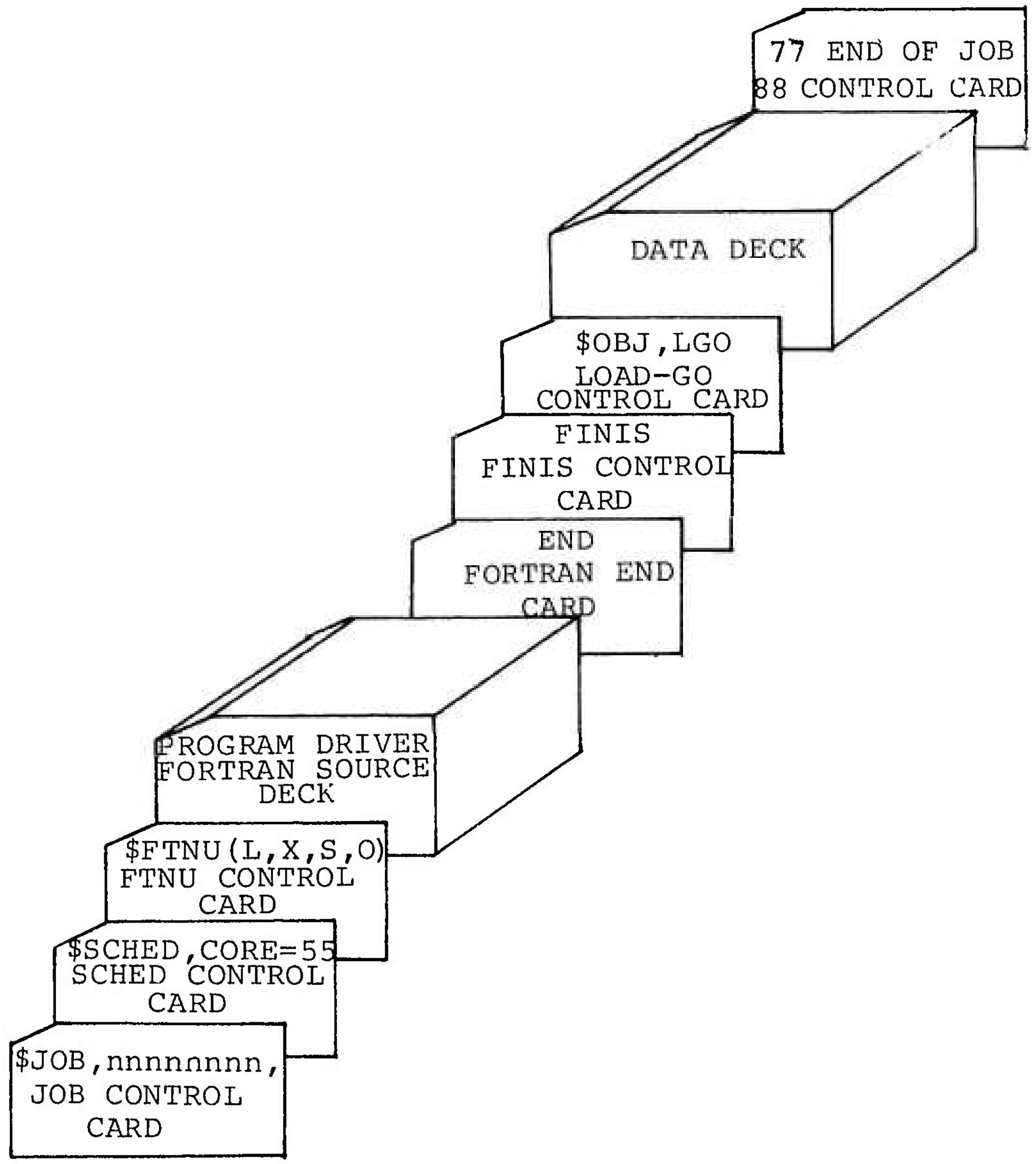


Figure 7. Total Deck Set-Up for Fortran Compilation and Execution.

Note: For FORTRAN Compilation and Execution on Control Data Corporation Hardware Operating Under the MASTER Operating System.

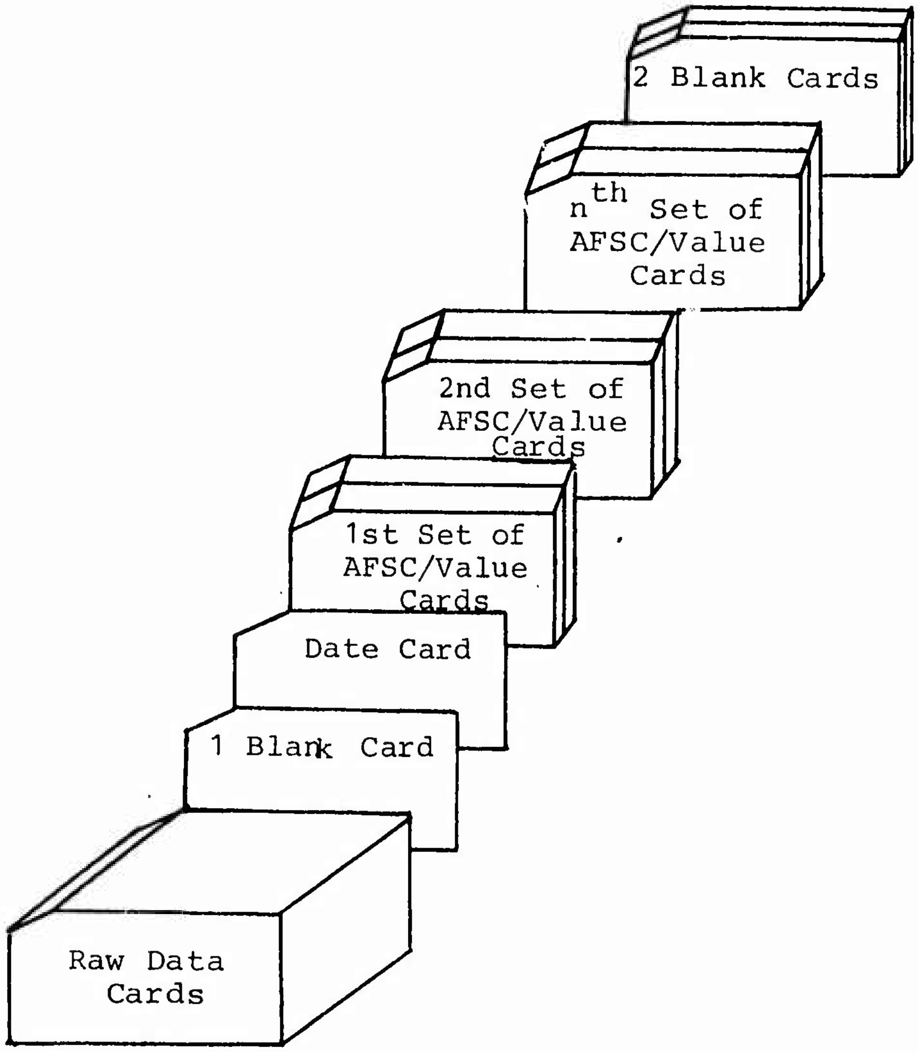


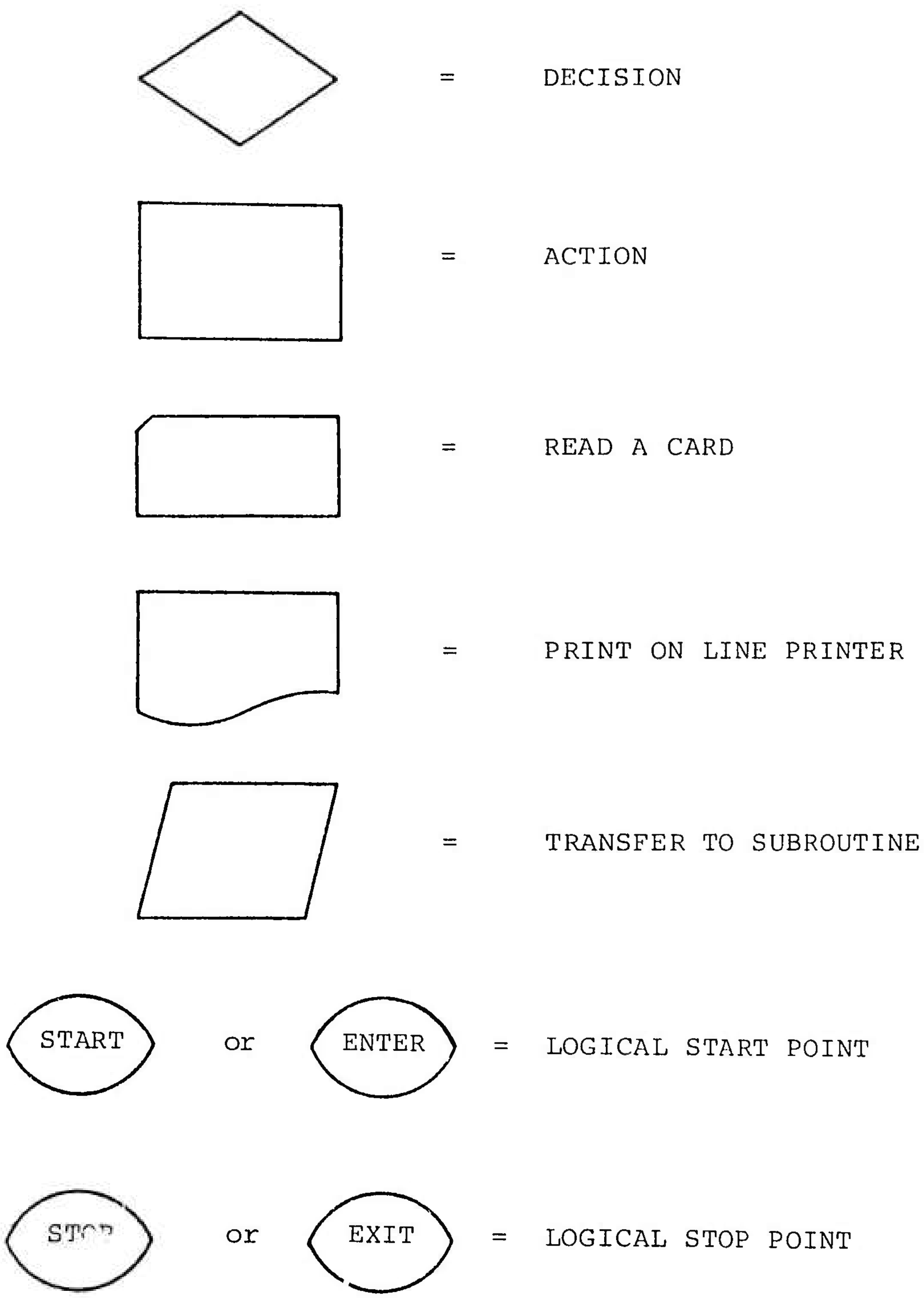
Figure 8. Data Deck Set-Up for the COMMONALITY SORT Program.

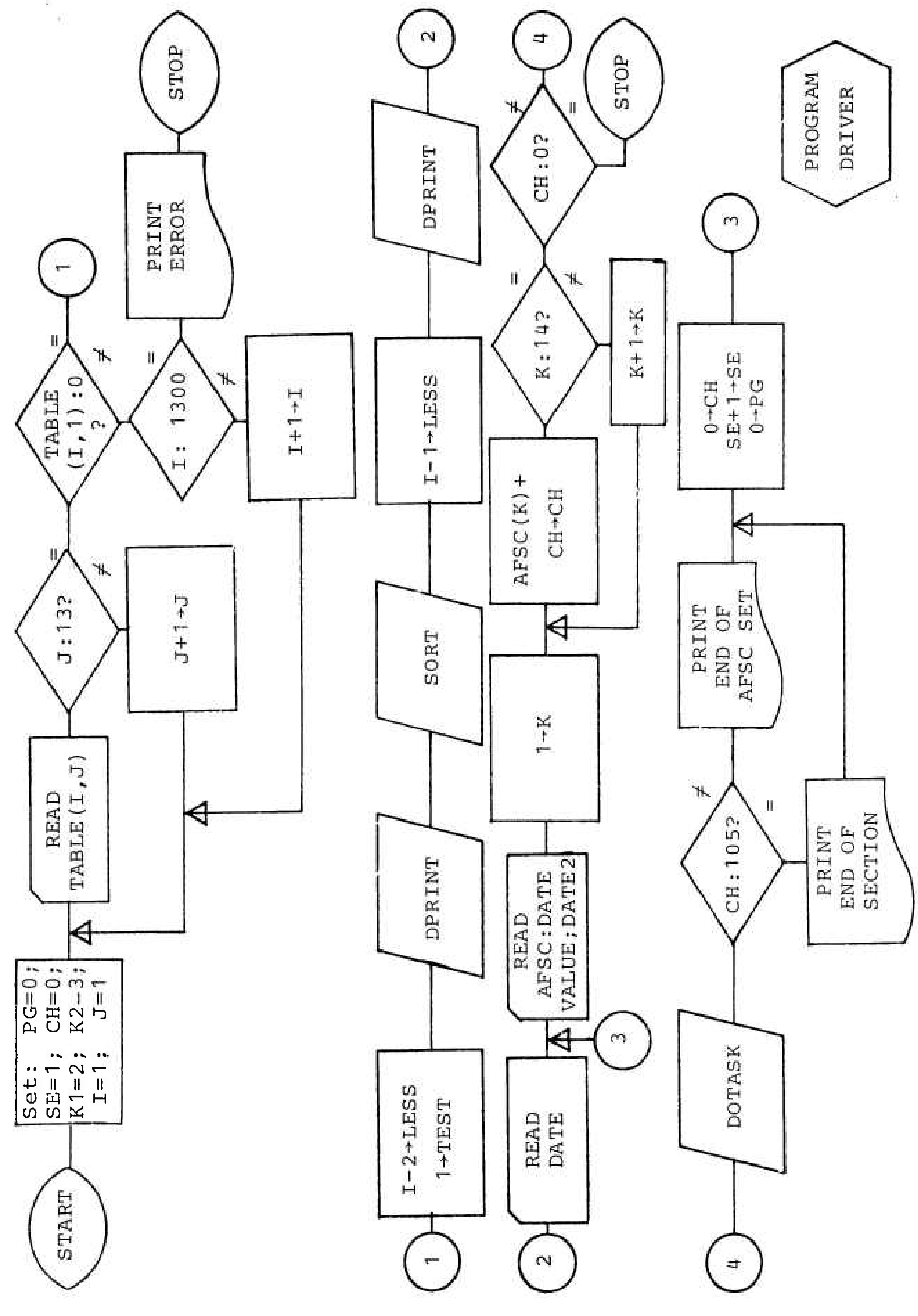
must be supplied the OS by the programmer using a special OS-specific job control language (JCL). These instructions tell the <u>OS</u> (not the computer) about the various parameters of the job <u>to</u> be run that are necessary for efficient use of the computer. These parameters include estimates of the amount of total CPU time necessary for the job, the number of lines of output expected, how much core storage the program will require, etcetera.

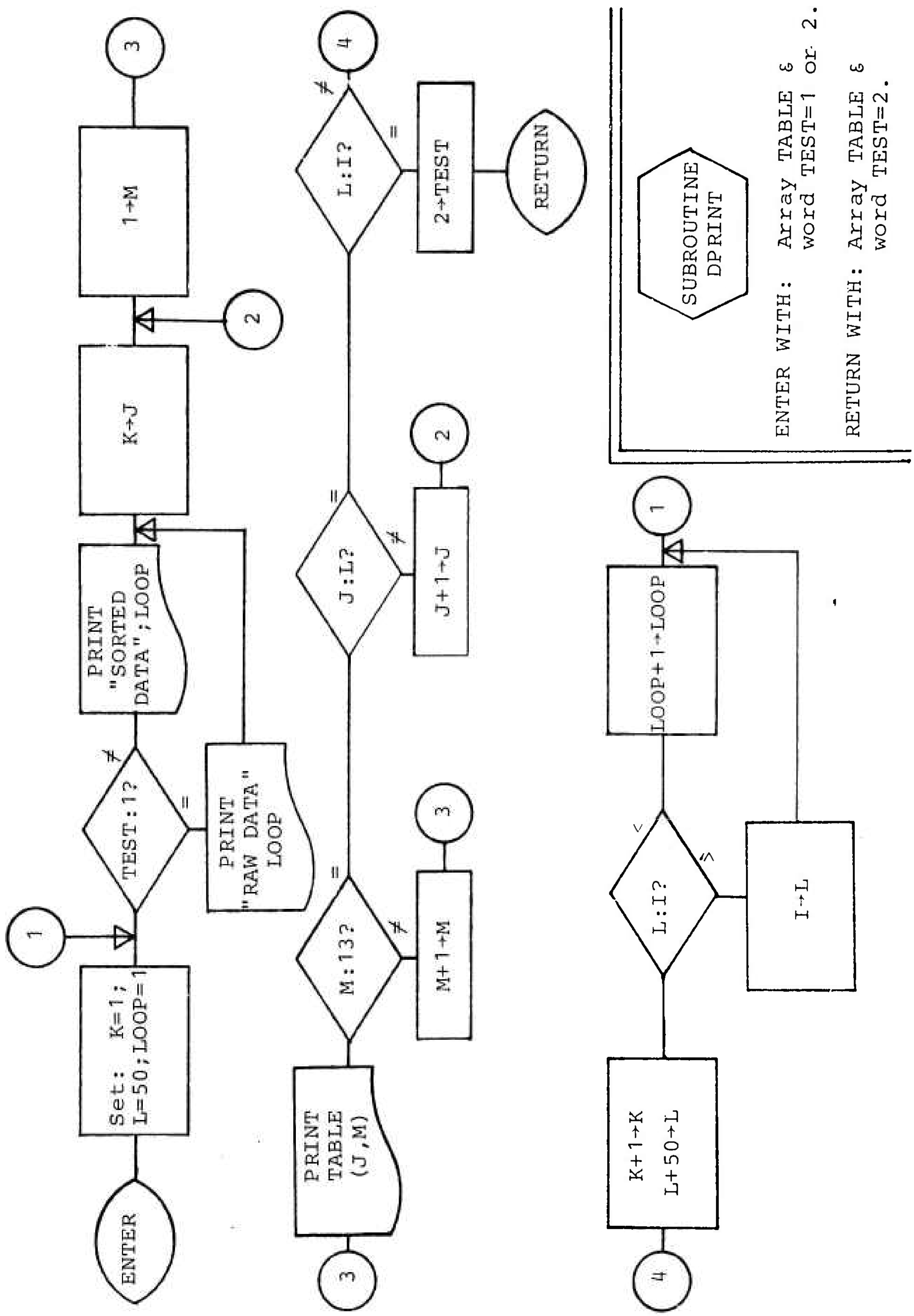
JCL is supplied via specialized input cards called "control cards". An example of a control card for the MASTER operating system would be the $JOB card which appears as the very first card in the program deck. Following the format $JOB,nnnnnnnn, uuuuuu,ttttt,lllll,ppppp,sssss,cccc...., this particular card (for the MASTER operating system) supplies the OS with first the account number (n) to charge CPU time to, the user's name (u), the user's estimate of CPU time (t), the user's estimate of the number of lines of output (l), his estimate of the number of punched cards to be produced (p) and the sequence (s) of the particular job in the user's job flow. The c field is then reserved for any comments the user may desire to include on his $JOB card. Other control cards used with MASTER that appear in the COMMONALITY SORT program deck include the $SCHED card (which schedules CPU storage and scratch file area, among other possible parameters), the FINIS card (which tells the OS that there are no further source language (in the COMMONALITY SORT program, FORTRAN) cards to compile (or translate), the $OBJ,LGO card (which instructs MASTER to load the translated source language or "object" (OBJ) code into the CPU and pass control over to the object program (LGO)), and the $^{77}_{88}$ EOJ card (which, as the very last card in the entire program deck, tells the OS that the end of the job (EOJ) has been accessed).

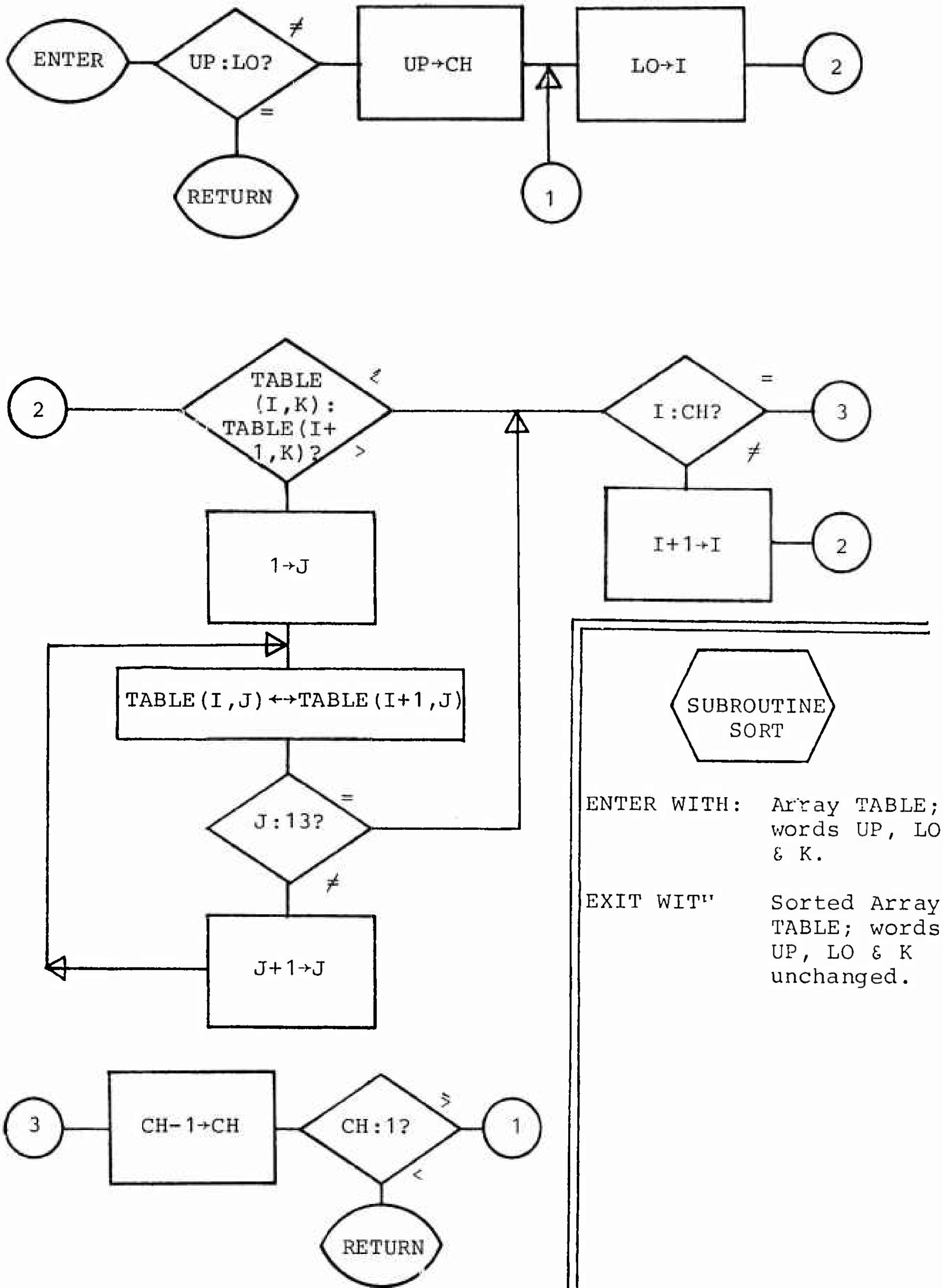
The COMMONALITY SORT program was designed to run, unaltered, on all CDU 3000 Series computers operated under the DCD MASTER OS. Operation on CDC 3000 Series computers under OSs other than MASTER (MSOS, for example) will require a change in JCL control cards and, in some cases, minor changes to FORTRAN source language cards. For operation on other CDC computers using the CDC-modified ANSI FORTRAN compiler, the user must first determine if (1) MASTER OS control cards are usable and (2) whether or not FORTRAN source language cards will have to be altered. A precautionary message of this type is necessary because no two computers are the same and no program will run, normally, in the correct manner on two different computers even if they are of the same manufacture and model. Each installation has its own individual peculiarities and, therefore, each program must be tailored to the computer upon which it is to be run.

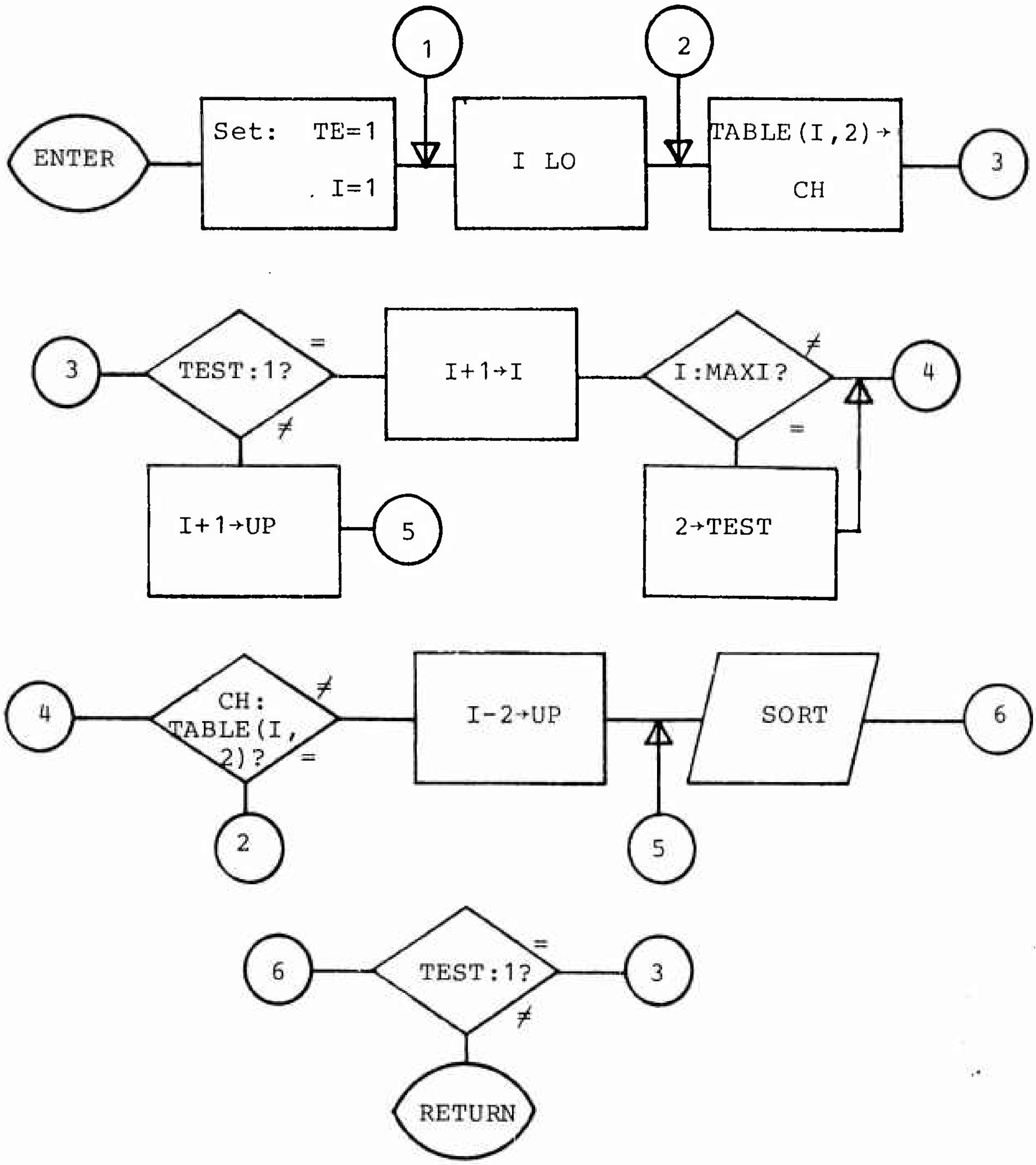
FLOWCHART SYMBOLS

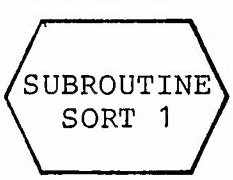



START
Set: PG=0; SE=1; CH=0; K1=2; K2=3; I=1; J=1
READ TABLE(I,J)
J:13?
J+1→J
TABLE (I,1):0 ?
I: 1300
I+1→I
PRINT ERROR
STOP
I−2→LESS 1→TEST
DPRINT
SORT
I−1→LESS
DPRINT
READ DATE
READ AFSC:DATE VALUE;DATE2
1→K
AFSC(K)+ CH→CH
K:14?
K+1→K
CH:0?
STOP
DOTASK
CH:105?
PRINT END OF SECTION
PRINT END OF AFSC SET
0→CH SE+1→SE 0→PG
PROGRAM DRIVER


ENTER
Set: K=1; L=50;LOOP=1
TEST:1?
PRINT "RAW DATA" LOOP
PRINT "SORTED DATA";LOOP
K→J
1→M
M:13?
M+1→M
PRINT TABLE (J,M)
J:L?
J+1→J
L:I?
2→TEST
RETURN
L:I?
I→L
LOOP+1→LOOP
K+1→K
L+50→L
SUBROUTINE DPRINT
ENTER WITH: Array TABLE & word TEST=1 or 2.
RETURN WITH: Array TABLE & word TEST=2.

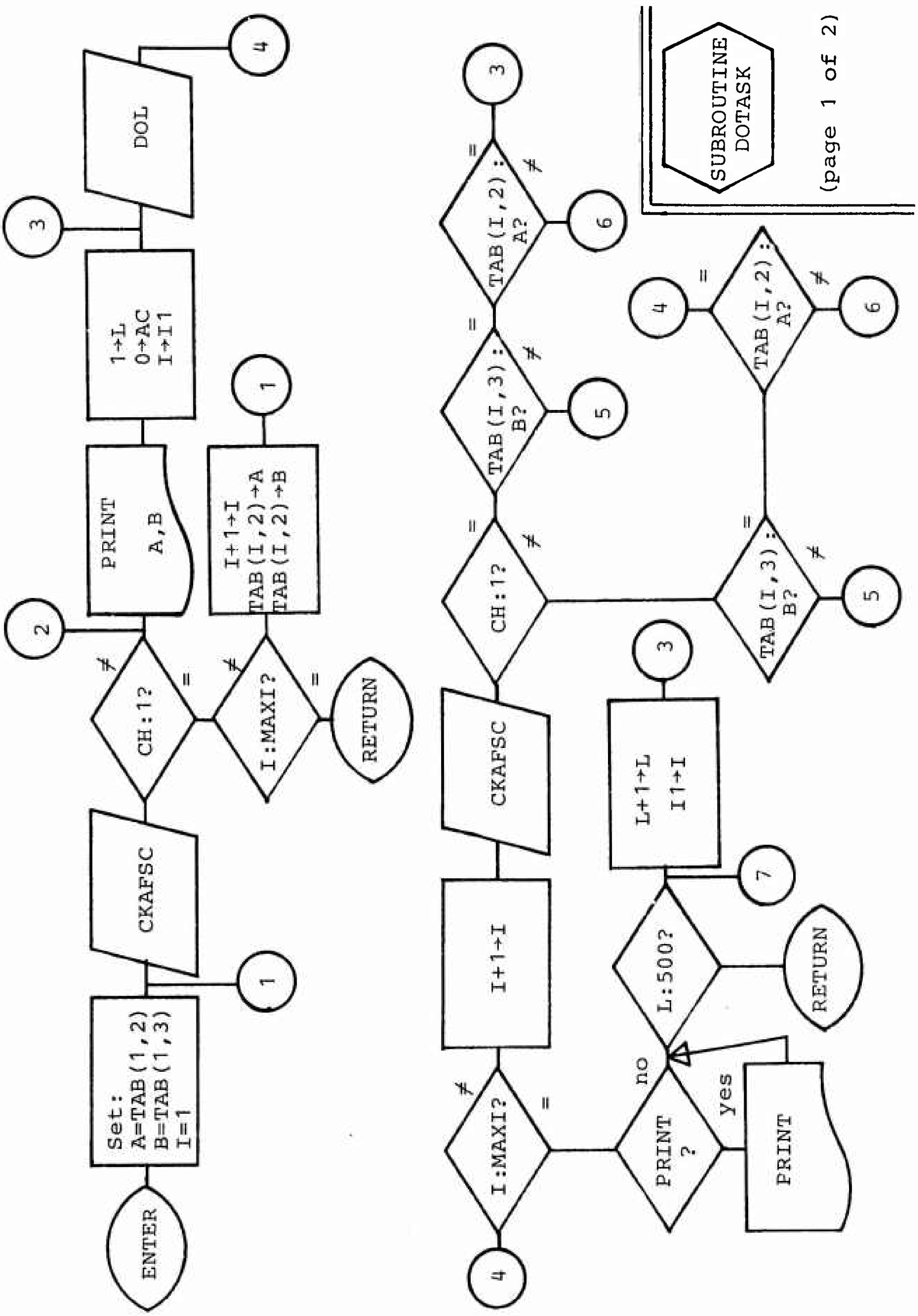

ENTER
UP:LO?
≠
=
RETURN
UP→CH
LO→I
1
2
2
TABLE (I,K): TABLE(I+1,K)?
≤
>
1→J
TABLE(I,J)↔TABLE(I+1,J)
J:13?
=
≠
J+1→J
I:CH?
=
≠
3
I+1→I
2
3
CH-1→CH
CH:1?
≥
<
1
RETURN
SUBROUTINE SORT
ENTER WITH: Array TABLE; words UP, LO & K.
EXIT WIT" Sorted Array TABLE; words UP, LO & K unchanged.

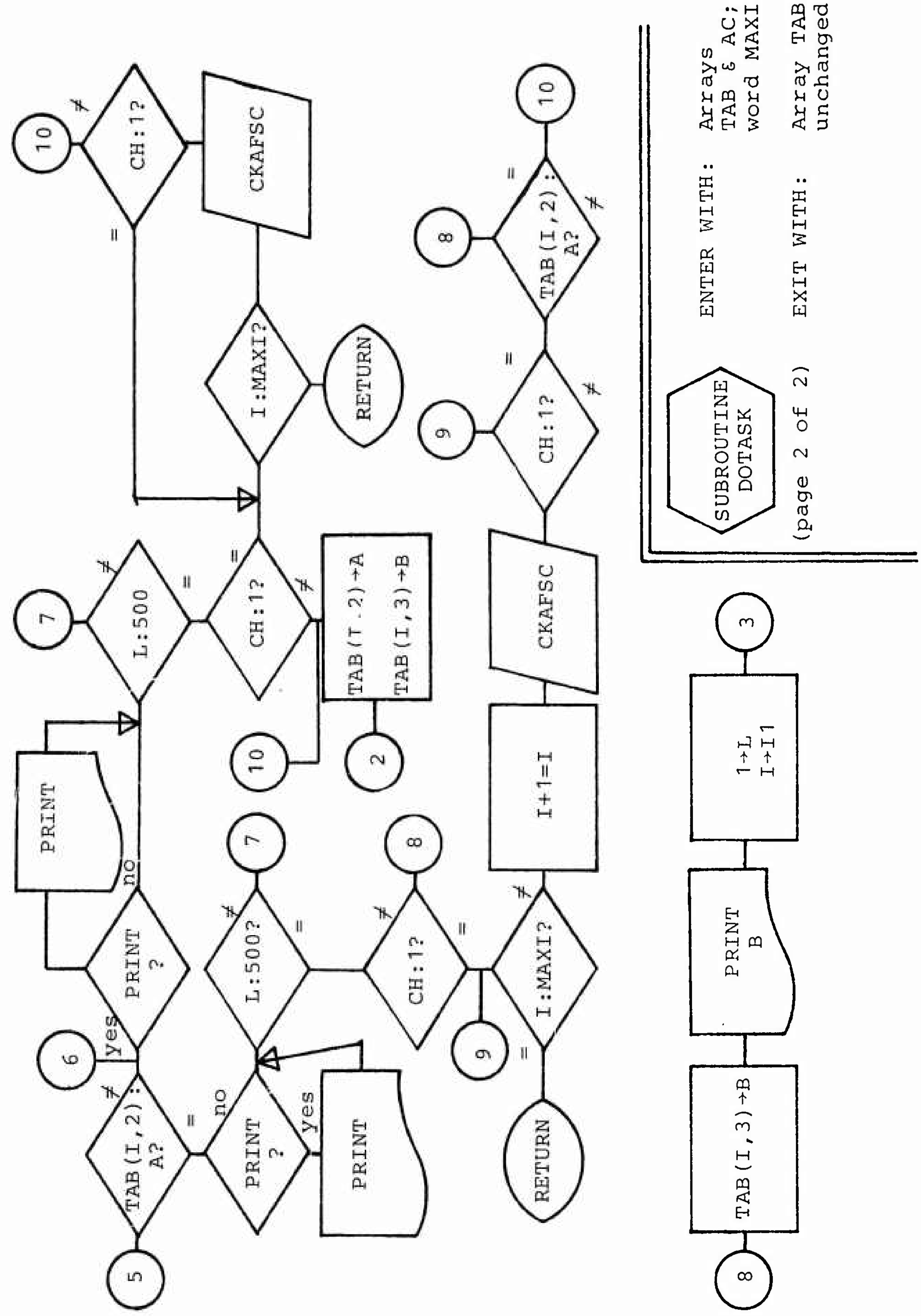


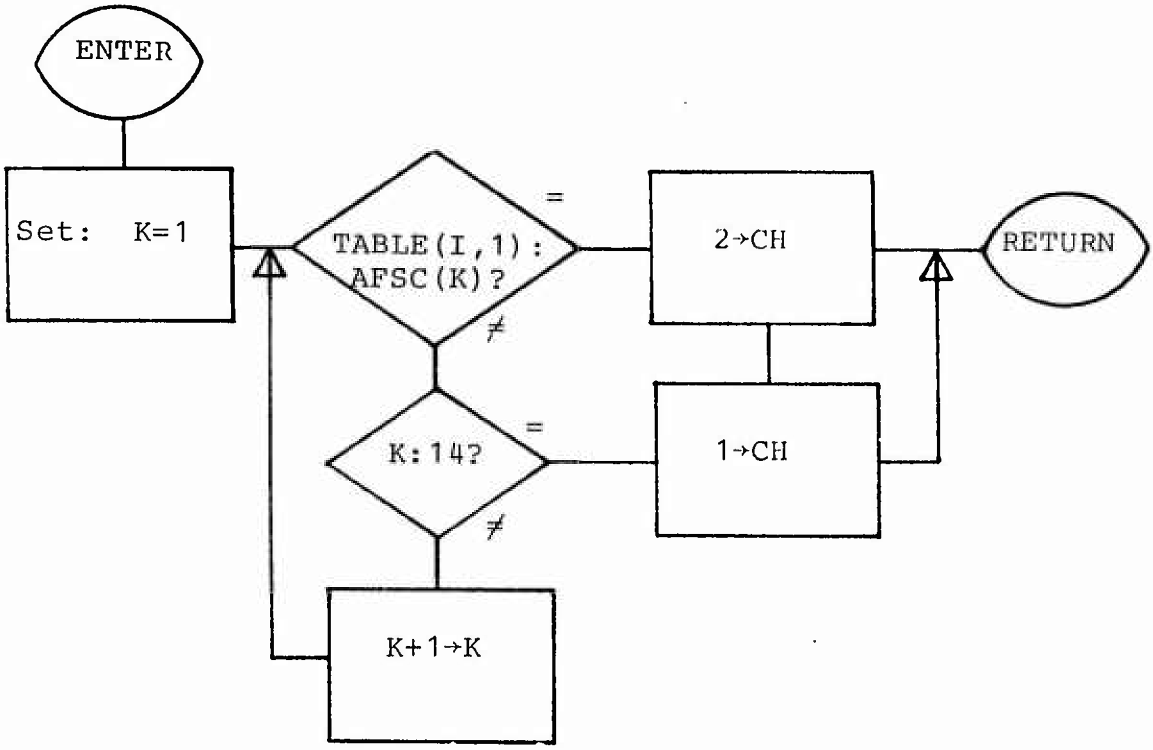


ENTER WITH: Array TABLE; words MAXI & K.

EXIT WITH: Array TABLE; words MAXI & K, array TABLE having been resorted.


ENTER
Set:
A=TAB(1,2)
B=TAB(1,3)
I=1
1
CKAFSC
CH:1?
2
PRINT
A,B
1→L
0→AC
I→I1
3
DOL
4
I:MAXI?
I+1→I
TAB(I,2)→A
TAB(I,2)→B
1
RETURN
4
I:MAXI?
I+1→I
CKAFSC
CH:1?
TAB(I,3):
B?
5
TAB(I,2):
A?
6
3
PRINT
?
no
yes
PRINT
L:500?
RETURN
7
L+1→L
I1→I
3
TAB(I,3):
B?
5
TAB(I,2):
A?
6
4
SUBROUTINE
DOTASK
(page 1 of 2)

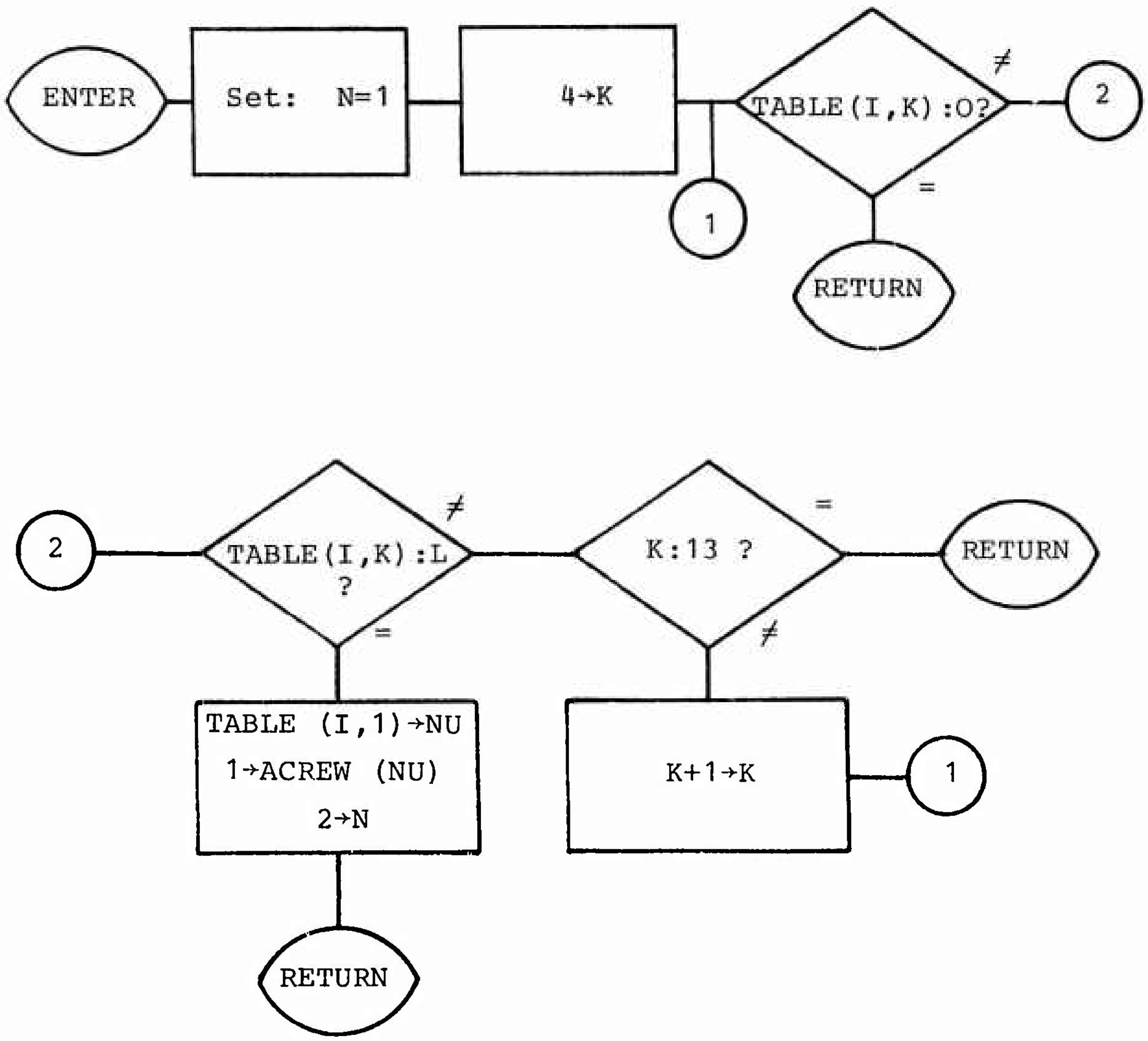

SUBROUTINE DOTASK
(page 2 of 2)
ENTER WITH: Arrays TAB & AC; word MAXI.
EXIT WITH: Array TAB unchanged.
TAB(I,2): A?
PRINT ?
PRINT
yes
no
L:500
L:500?
CH:1?
CH:1?
I:MAXI?
CKAFSC
RETURN
TAB(I,2)→A
TAB(I,3)→B
I+1=I
TAB(I,3)→B
PRINT B
1→L
I→I1
=
≠
5
6
7
8
9
10
2
3



SUBROUTINE
CKAFSC

ENTER WITH: Arrays TABLE & AFSC; words I & CH.

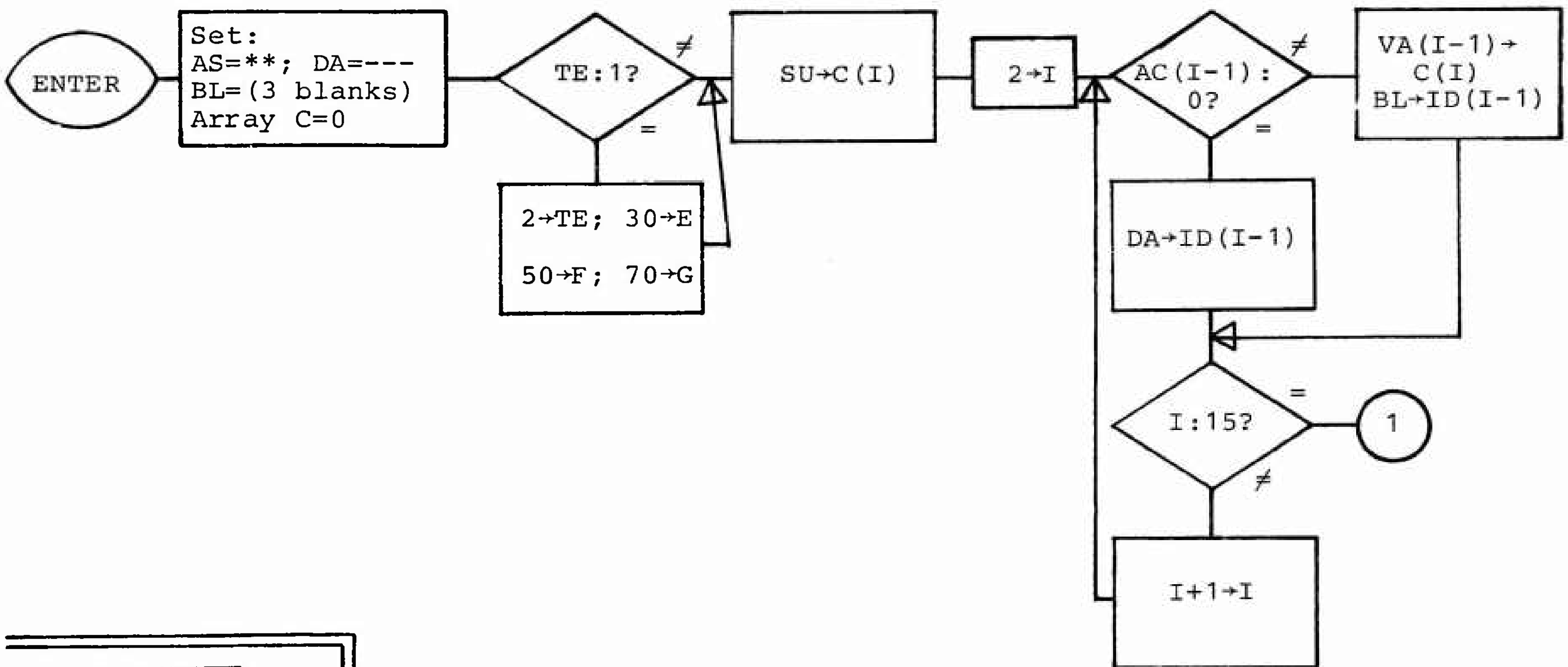
EXIT WITH: Arrays TABLE & AFSC unchanged. Word I is unchanged, while word CH contains either the integer 1 or 2.



SUBROUTINE DOL

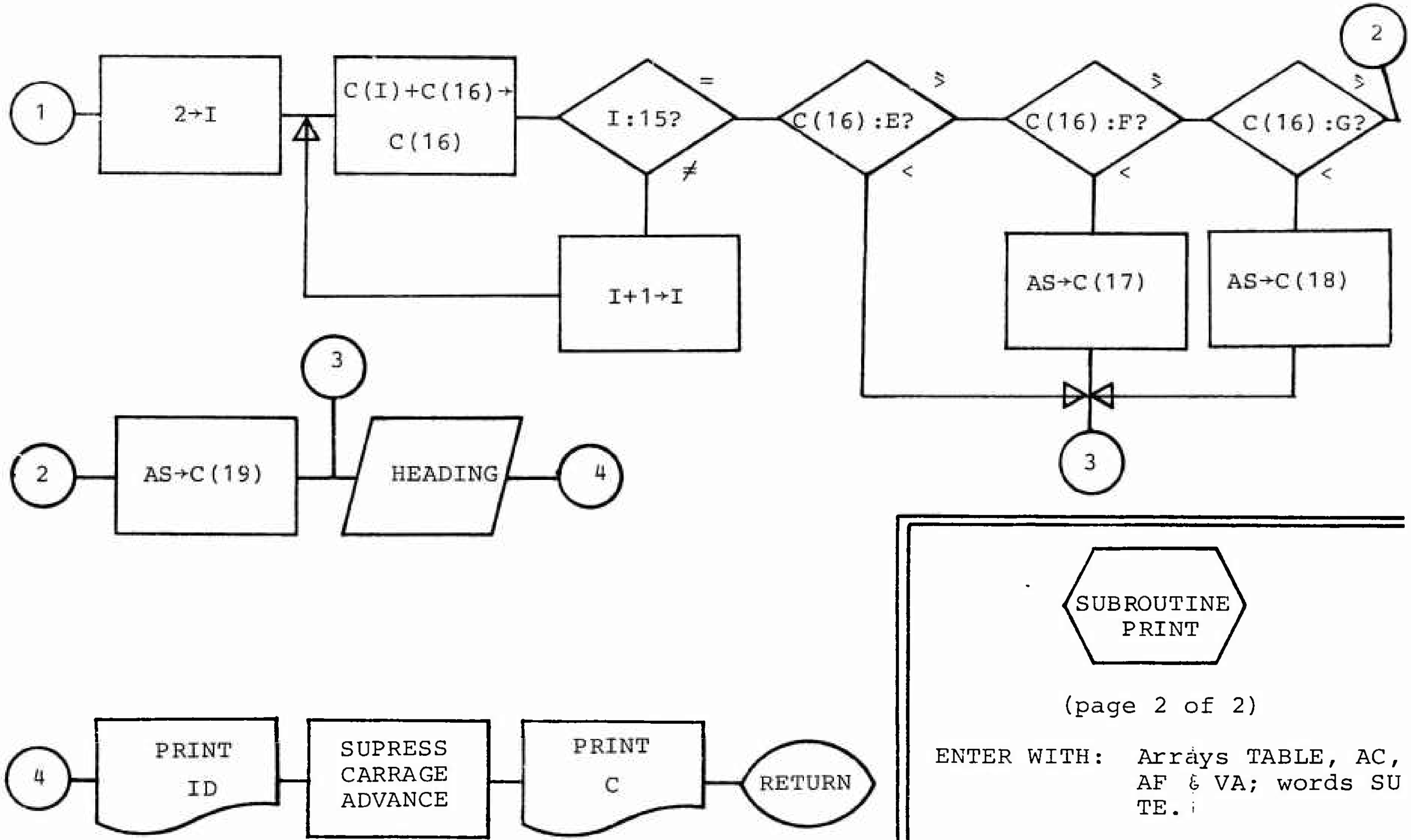
ENTER WITH: Arrays TABLE & ACREW; words I, N & L.

EXIT WITH: Array TABLE, & words I, N & L unchanged. Significant elements of array ACREW contain the integer 1.



SUBROUTINE PRINT

(page 1 of 2)

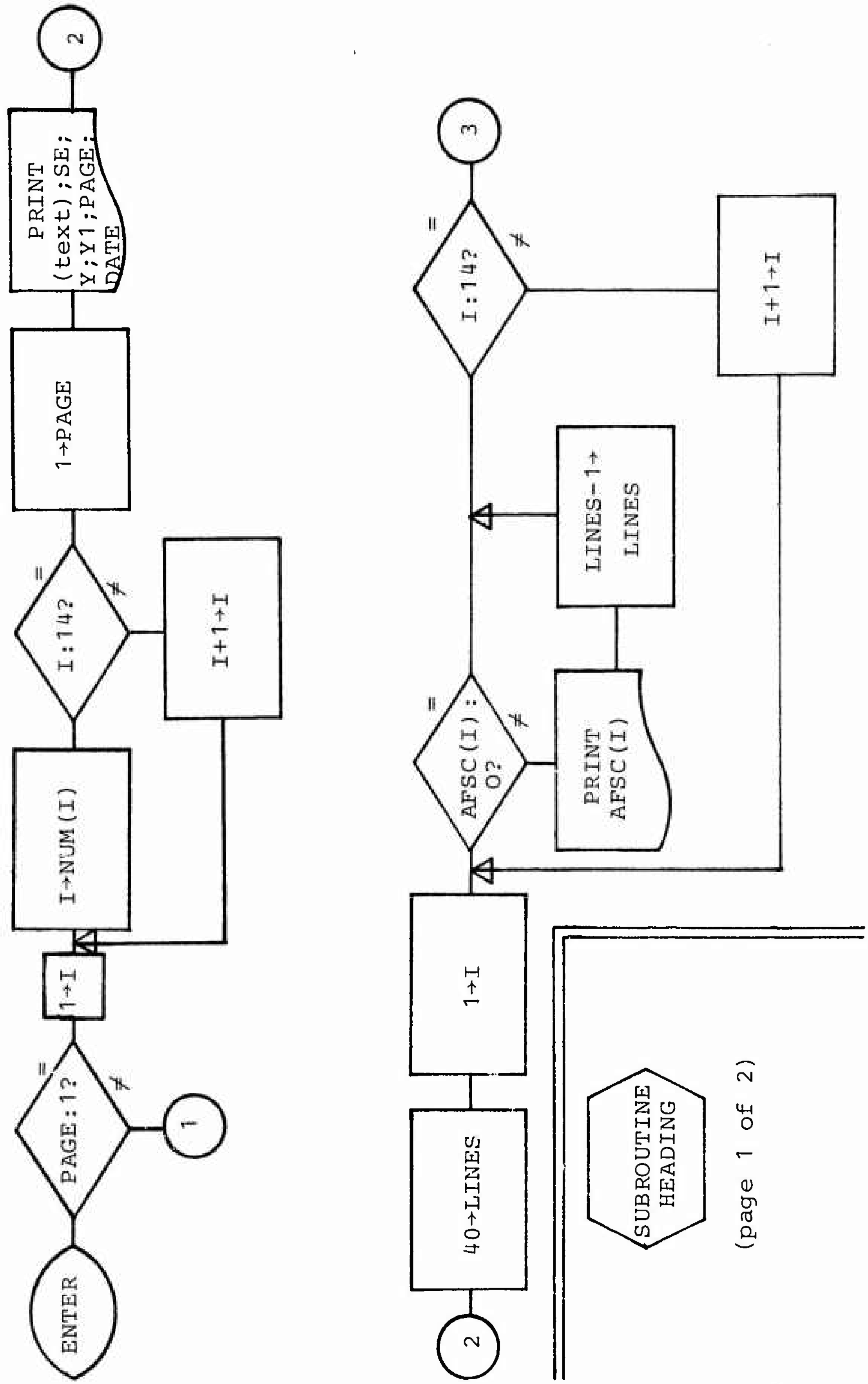


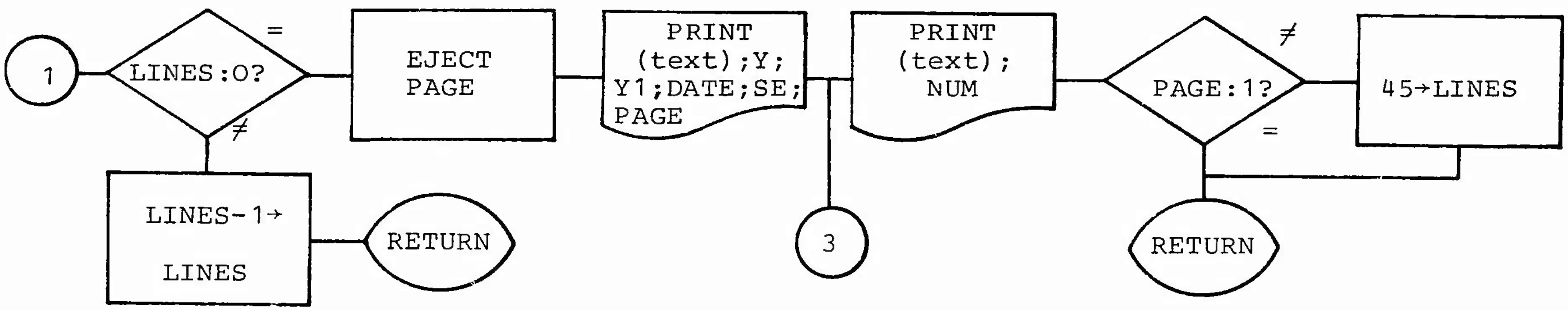
SUBROUTINE PRINT

(page 2 of 2)

ENTER WITH: Arrays TABLE, AC, AF & VA; words SU & TE.

EXIT WITH: All arrays and words unchanged.


ENTER
PAGE:1?
=
≠
1
1→I
I→NUM(I)
I:14?
=
≠
I+1→I
1→PAGE
PRINT (text);SE; Y;Y1;PAGE; DATE
2
2
40→LINES
1→I
AFSC(I): 0?
=
≠
PRINT AFSC(I)
LINES-1→ LINES
I:14?
=
≠
I+1→I
3
SUBROUTINE HEADING
(page 1 of 2)



ENTER WITH:	Arrays TABLE, ACREW, AFSC, VALUE, DATE & C; words Y, Y1, PAGE & SE.
EXIT WITH:	Arrays unchanged. Words Y, Y1 & SE unchanged. Word PAGE varied to coincide with the page number being printed.

(page 2 of 2)

SECTION VII

DEFINITIONS AND ABBREVIATIONS

EXPLANATION

Part A of Section VII lists and defines abbreviations used in the task analysis portion of Phase II of the NOUFFSS study. The abbreviations are listed in alphabetical order.

Part B of Section VII lists and defines technical terms used in Phase II of the NOUFFSS study. Terms are presented in alphabetical order and are defined as used and discussed in the NOUFFSS study.

PART A. TASK ANALYSIS DATA ABBREVIATIONS

A/C	Aircraft
ADF	Automatic Direction Finder
ADIZ	Area Defense Interrogation Zone
ADS	Air Defense System
AF	Air Force
AFSC	Air Force Specialty Code
AHRU	Attitude Heading Reference Unit
ALT	Altitude
ARA	Airborne Radar Approach
ARCP	Air Refueling Control Point
ARIP	Air Refueling Initial Point
ARR	Additional Research Required
ATC	Air Traffic Control
ATC	Air Training Command
AWACS	Airborne Warning and Control System
BDHI	Bearing Distance Heading Indicator
BDM	Bomber Defense Missile
BIT	Build in Test
CARP	Computed Air Release Point
CBS	Circuit Breakers
CCT	Combat Crew Training
CCW	Counter Clockwise
COMM	Communication
CEP	Circular Error Probable
DEG	Degree
DME	Distance Measuring Equipment
DR	Dead Reckoning

DZ	Drop Zone
ECM	Electronic Countermeasure
ECCM	Electronic Counter-Countermeasures
ELINT	Electromagnetic Intelligence
EMAC	Energy Management Computer
EOB	Electronic Order of Battle
ETA	Estimated Time of Arrival
ETP	Emergency Timing Point
EWO	Electronic Warfare Officer (AFSC 1575)
EWOT	Electronic Warfare Officer Training
FAA	Federal Aviation Administration
FLR	Forward Looking Radar
FUPT	Future Undergraduate Pilot Training
GCA	Ground Control Approach
GCI	Ground Control Intercept
GND	Ground
GPI	Ground Position Indicator
HF	High Frequency
HSI	Horizontal Situation Indicator
IDNE	Inertial Doppler Navigation Equipment
IFF	Identification Friend or Foe
ILS	Instrument Landing System
INS	Inertial Navigation System
IP	Initial Point
ISD	Instructional System Development
KT	Knot
LAT	Latitude
LF	Low Frequency
LLLTV	Low-Light-Level Television
LONG	Longitude
LORAN	Long Range Radio Navigation
MAC	Military Airlift Command
MIN	Minute or Minimum
MMR	Multimode Radar
MSG	Message
MWA	Military Weather Advisory

NA	Not Applicable
NAV	Navigation
NBT	Navigator-Bombardier Training
NM	Nautical Miles
NOTAMS	Notice to Airmen
OB	Order of Battle
OMEGA	Recently Developed Radio Nav-Aid
O-P	Operational Procedure
OXY	Oxygen
PAN SCOPE	Electronic Warfare Display
PCT	Percent
PERF CRIT	Performance Criteria
PIP	Pre-Initial Point
PM	Plus or Minus
POS	Position
REGS	Regulations
SAC	Strategic Air Command
SAMOB	Surface to Air Missile Order of Battle
SEC	Second (Time)
SEWT	Simulator for Electronic Warfare Training
SID	Stellar-Inertial-Doppler Nav System
SID	Standard Instrument Departure
SIF	Secure Identification Feature
SIGMETS	Significant Meteorological Reports
SLR	Side-Looking Radar
SOP	Standard Operational Procedure
SPD	Speed
SRAM	Short Range Attack Missile
SYS	System
TAC	Tactical Air Command
TACAN	Tactical Air Navigation System
TAR	Terrain Avoidance Radar
TAS	True Airspeed
TBD	To Be Determined
TFR	Terrain Following Radar
TO	Technical Order

TTG	Time To Go
TV	Television
UHF	Ultra High Frequency
VHF	Very High Frequency
VLF	Very Low Frequency
VOR	VHF Omni-Directional Range
WSO	Weapon System Officer (AFSC 1555)

PART B. DEFINITION OF TECHNICAL TERMS USED IN PHASE II

All-Inclusive Sort - A commonality analysis (commonality sort) addressing all 14 of the aircraft/crew position combinations found in the NOUFFSS sample. In this case, all four of the AFSCs in the NOUFFSS sample are addressed. (This is the same as "across all AFSCs" and "across all weapon systems".)

Common/Non-Common - A statistical decision based on criteria selected for a given population in a particular application which determines if a given attribute, parameter, task, or measurement is applicable (or "common") to the subject population. Such criteria vary with the subject population, the treatment applied to the data, and the purpose or expected application of the data.

Commonality Analysis - A methodology applied to task analysis data to indicate the relative numbers (percents) of individuals in the sample population who perform various subtasks.

Crew Position Code - A numerical code (1 through 14) assigned to each of the 14 aircraft/crew position combinations found in the NOUFFSS sample.

Function - A broad system activity contributing to mission performance.

Functional Orientation - An approach to task analysis stressing types and kinds of job-related activity clusters rather than specific sequence in which job activities are performed.

Microfunctions - Functionally-oriented clusters of procedural steps.

Navigator - A generic term used to collectively refer to Navigators (AFSC 1535), Radar Navigators (AFSC 1525), Weapon System Officers (AFSC 1555) and Electronic Warfare Officers (AFSC 1575).

Sort - A computer based commonality analysis using blocks of task data for determination of the commonality of task data at subtask level in relation to the sample (or subsets of the sample) population.

Subjective - Individual interpretation or analysis usually involving "reading between the lines" of the data presented.

Subtask - Subgoals associated with or required for the accomplishment of task level behavioral requirements.

Task - Unit of work performed by the operator in order to accomplish mission level requirements.

Task Analysis - A procedure used to identify, organize and present job elements which are carried out by the human operator during the use or maintenance of man-machine systems. A method for providing information regarding human components within a systems context, describing job behaviors, and analyzing behaviors for design content.

Timeline Orientation - An approach to job or task description based upon the sequences in which tasks occur and the time intervals separating the performance of various tasks.

Value Sum - A commonality analysis term. For any given subtask, the computer-generated total of all individual commonality weighting factors.

Weighting Factor - A numerical factor designed to weight subtasks in proportion to the number of people who perform them. Two classes of weighting factors were used in the NOUFFSS study.

One class was used for the "all inclusive" commonality analyses. For "all inclusive" analyses, weighting factors represented the relative numbers (percents) of navigators in each of the 14 aircraft/AFSC position combinations compared to the total number of navigators in all 14 positions. For example, if aircraft/AFSC position 10 had a weighting factor of 13, this meant that the number of navigators required for crew position 10 comprised 13% of all of the navigators required for all 14 different aircraft/AFSC positions. If only aircraft/AFSC position 10 performed a given subtask, then that subtask's total commonality weight (value sum) would have been 13. If, on the other hand, all 14 crew positions performed the subtasks, then the total commonality weight (value sum) would have been 100.

The second class of weighting factors was used for "within AFSC" commonality analyses. For "within AFSC" analyses, weighting factors represented the relative numbers (percents) of navigators in each aircraft/AFSC position of the same AFSC compared to the total number of all navigators in that AFSC. If, for example, aircraft/AFSC positions 3, 5, 9 and 10 all were AFSC 1535 and there were no more AFSC 1535s, then the weighting factors for aircraft/AFSC position 10 would have been the relative number (percent) of people filling position 10 in relation to the total number of all people filling positions 3, 5, 9 and 10.

Within (AFSC) Sort - A commonality analysis (Commonality Sort) addressing only one of the four AFSCs found in the NOUFFSS sample. (This is the same as "within weapons system" sort.)

SECTION VIII

TASK ANALYSIS CARD DATA FIELDS

EXPLANATION

All NOUFFSS Phase II task analysis data were keypunched for computer data base use. Fifteen different types of data cards were keypunched, each card with unique data fields. This section describes information contained on each card, and the data fields allocated for each information item.

In the listing below, data fields are identified separately for each card type. The column "abbreviation" contains the acronym which was used to identify each data field for visual examination. The numbers shown in parentheses to the immediate right of each abbreviation are the card columns used to keypunch the acronyms. The column to the right of "abbreviation" presents the full title or meaning of the abbreviation. The far right-hand column presents data card columns (fields) which were dedicated to data entry for each abbreviated data item.

Card Type	Abbreviation	Meaning	Data Field Card Columns
01	FN (10, 11)	Function Number	13 - 14
	D (20)	Data Collection Date	22 - 27
	S (30)	System	32 - 38
02	MN (10, 11)	Mission Type	13 - 33
	P (37)	Mission Phase	39 - 51
03	FUNC (5-8)	Function Title	10 - 73
04	TASK (5-8)	Task Title	10 - 73
05	TN (10, 11)	Task Number	13 - 15
	ENT (20-22)	Entry Number	24 - 26
	TIME (30-33)	Task Time	35 - 39
06	SRCE (5-8)	Information Source	10 - 73
07	TICN (5-8)	Task Initiating Conditions	10 - 73
08	TALT (5-8)	Task Alternatives	10 - 73
09	SN (10, 11)	Subtask Number	13 - 15
	SC (20, 21)	AFSC	23 - 26
	FR (30, 31)	Subtask Frequency	33 - 34
	CR (37, 38)	Subtask Criticality	40
	DP (43, 44)	Subtask Performance Difficulty	46
	DL (49, 50)	Subtask Learning Difficulty	52
	TD (55, 56)	Training Device Recommendation	58
	MD (61, 62)	Measurement Device	64
	T (67)	Subtask Time	69 - 72

10	SYS (10-12)	Aircraft System	14 - 25
	HDW (30-32)	Aircraft Hardware	34 - 47
	NO (49, 50)	Hardware Designator	52 - 73
11	SKILL (10-14)	Required Skill	16 - 73
12	KNOWL (10-14)	Required Knowledge	16 - 73
13	MP (10, 11)	Measurement Parameter	13 - 28
	MS (30, 31)	Measurement Standard	33 - 41
	MP (43, 44)	Measurement Parameter	46 - 59
	MS (61, 62)	Measurement Standard	64 - 73
14	SUBT (5-8)	Subtask Title	10 - 73
15	MFTN (5-8)	Microfunction	10 - 73

Multiple cards were used, as required, for certain types of entries. For example, card type 06 contains textual descriptions of the sources of the task analysis information. More than one type 06 card was used, as required, if the sources of information simply would not fit into the data field spaces allocated for a single type 06 card. Accordingly, card type numbers could appear as follows: 01, 02, 03, 04, 05, 06, 06, 06, 07, etc.

Similarly, multiple entries were used, as required, for the following card types: 06, 07, 08, 10, 11, 12, 13, and 15.

Two rules applied to all card types. First, column one of each card was not used. Second, columns 75 and 76 were used to enter a system number. Columns 77 - 80 contain card accession numbers. The system and accession number entries were included to provide a means for correctly re-ordering the cards in the event that one or more decks might be dropped or in some other fashion become disarranged.

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13. ABSTRACT

Appendix II presents information developed during Phase II of a three-phase study designed to provide a technical basis for determining future (1975-1990) navigator training requirements. The term navigator is used generically to refer to navigator (AFSC 1535), Radar Navigator (Navigator-Bombardier) (AFSC 1525), Weapon Systems Officer (AFSC 1555), and Electronic Warfare Officer (AFSC 1575). This appendix addresses the methodology which was developed and used to determine common and non-common operational task requirements across all navigator flying specialties, as well as within each flying specialty. Task description and analysis methods are presented along with data collection and validation procedures. Computer software developed for determining common and non-common tasks is presented. Rationale for deriving task commonality criteria is addressed. Supplementary Phase II classified task analysis and commonality analysis information is presented in a separate section (Section IX) of the secret Appendix I, entitled Present and Future Roles of the Navigator (U), in order to keep all classified information in a single document for control purposes.

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14 KEY WORDS	LINK A		LINK B		LINK C	
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